Biological Assessment

Mount Tom Generating Station National Pollutant Discharge Elimination System Permit Reissuance (Permit No. MA0005339)

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1.0 INTRODUCTION

The purpose of this Biological Assessment (BA) is to address the effect of First Light Power Resources' Mount Tom Generating Station (MTGS) National Pollutant Discharge Elimination System (NPDES) Permit reissuance on federally protected species. Federally protected species are listed as endangered or threatened under the Endangered Species Act (ESA). Section 7(a) of the Endangered Species Act of 1973 (ESA), as amended, grants authority to and imposes requirements upon Federal agencies regarding endangered or threatened species of fish, wildlife, or plants ("listed species") and habitat of such species that has been designated as critical (a "critical habitat"). The ESA requires every Federal agency, in consultation with and with the assistance of the Secretary of Interior, to insure that any action it authorizes, funds, or carries out, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The United States Fish and Wildlife Service (USFWS) administers Section 7 consultations for freshwater species. The National Marine Fisheries Service (NMFS) administers Section 7 consultations for marine species and anadromous fish.

The Environmental Protection Agency (EPA) is taking this permit reissuance action in order that the facility maintains compliance with the provisions of the Federal Clean Water Act (CWA), as amended, (33 U.S.C. §§1251 et seq.; the "CWA"), and the Massachusetts Clean Waters Act, as amended, (M.G.L. Chap. 21, §§ 26-53). The CWA prohibits the discharge of pollutants to waters of the United States without an NPDES permit unless such a discharge is otherwise authorized by the CWA. The regulations governing the EPA NPDES permit program are generally found at 40 CFR Parts 122, 124, and 125.

The federal action involves the permitting of a cooling water intake structure as well as the permitting of heated water discharge and water discharged from additional designated outfalls into the Connecticut River at river kilometer 148, in Holyoke, Massachusetts. The facility employs the regulated intake structure, cooling water and associated discharges to generate electricity. Because permitted activities will occur in the

Connecticut River, there is potential to impact the following ESA-listed species that occur in the area: Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*); shortnose sturgeon (*Acipenser brevirostrum*). There is no designated critical habitat for these species in the Connecticut River at this time.

Early coordination and pre-consultation with NMFS was conducted during a series of letter exchanges, communications and an informal Section 7 consultation between EPA and NMFS related to proposed ichthyoplankton sampling in the Connecticut River to collect biological information in support of NPDES permitting activities for MTGS. An informal Section 7 Consultation between EPA and NMFS to support the reissuance of the Chicopee Water Pollution Control Facility (WPCF) provided information on the newly listed Atlantic sturgeon in the Connecticut River. Important inter-agency letters include: September 11, 2007, information request letter (Section 308 of the CWA) from Stephen Perkins, EPA to John Murray, MTGS, cc:ed to Julie Crocker, NMFS; October 5, 2007, consultation recommendation letter pertaining to ichthyoplankton sampling from Patricia Kurkul, NMFS to Stephen Perkins, EPA; June 6, 2008, informal consultation request letter pertaining to ichthyoplankton sampling in April, July, August and September from David Webster, EPA to Mary Colligan, NMFS; August 5, 2008, completed consultation letter pertaining to Connecticut River ichthyoplankton sampling just upstream of MTGS in April, July, August and September from Patricia Kurkul, NMFS to David Webster, EPA; and a December 19, 2011, Chicopee Water Pollution Control Facility completed ESA consultation letter from Patricia Kurkul, NMFS to David Webster, EPA.

This BA, prepared by EPA and including information provided by MTGS, addresses the proposed action in compliance with Section 7(c) of the ESA of 1973, as amended. Section 7 of the ESA assures that, through consultation (or conferencing for proposed species) with NMFS, federal actions do not jeopardize the continued existence of any threatened, endangered or proposed species, or result in the destruction or adverse modification of critical habitat.

Portions of this BA were taken from a biological evaluation written on behalf of MTGS by Kleinschmidt and Associates and submitted to EPA on May 26, 2011, to support compliance with the ESA.

2.0 CONSULTATION HISTORY

In a September 11, 2007, letter EPA requested information from MTGS to support the reissuance of the station's NPDES permit. Among other information, EPA requested MTGS to conduct ichthyoplankton sampling in the mainstem of the Connecticut River in the vicinity of the MTGS to determine the type of species and abundance of early life stages (ELS) of fish that drift past the cooling water intake structure of the station. EPA required this sampling in accordance with Section 308 of the Clean Water Act. After a review of the plan, in a letter dated October 5, 2007, NMFS expressed concern that that the ichthyoplankton sampling may result in the capture and handling of shortnose sturgeon ELS. NMFS stated that this occurrence would constitute a "take' as defined by the ESA. As such, NMFS recommended a formal Section 7 consultation be completed before sampling could be performed. As part of this letter, NMFS also stated that EPA's reissuance of the NPDES permit for MTGS would also require a formal consultation. This BA was compiled and submitted to meet ESA Section 7 consultation requirements for the reissuance of the MTGS NPDES permit.

3.0 DESCRIPTION OF THE PROPOSED ACTION

MTGS is a coal powered electric generating facility capable of producing 147 megawatts (MW) of electricity to the electric grid. It is located along the western bank of the Connecticut River in Holyoke, Massachusetts at river km 148, approximately 7 miles upstream of the Holyoke Dam. The facility has been in operation since 1960 and withdraws cooling water from the Connecticut River and discharges heated effluent back to the river. Operational data from the past few years at MTGS show that the facility has been generating electricity at a lower percentage of capacity compared with its historical operation. In order to examine a period when Station operation was more typical and withdrawals and discharges of river water were closer to maximum permitted limits (i.e. a conservative approach) EPA chose the five year time period from 2000 through 2004.

The average capacity factor for MTGS based on 2000 through 2004 generation data was calculated to be 79.9 percent. The corresponding average daily intake flow, based on operating data from January 2000 through December 2004, was estimated to be 85.4 million gallons per day (MGD). The station consists of a single unit that utilizes a once-through cooling system. Cooling water is withdrawn from the Connecticut River through a 345 feet-long concrete intake pipe. The intake pipe terminates at the screenwell structure which contains two bays, each with one trash rack and a 10-feet wide traveling screen with 3/8-inch square mesh. The design velocity at each traveling screen at mean low water level is approximately 1.7 feet per second (fps). Downstream of the traveling screen, each bay contains a circulating water pump rated at 45,000 gallons per minute (gpm) and a river water pump rated at 2,500 gpm. Since only one river pump is operated at a time, the design intake flow for Mount Tom totals 92,500 gpm (133.2 MGD).

The withdrawal and discharge of cooling water and the discharges from outfalls at the Station are authorized by the EPA under NPDES Permit No. MA0005339 issued in 1992. This permit expired in 1997 and has been administratively continued. Through the renewal of this permit and the requirements of Section 316 and Section 402 of the Clean Water Act (CWA), EPA anticipates, at this time, that the permit limits governing water intake and discharge at the facility will remain generally as specified in the 1992 NPDES permit. A detailed list of all discharge limits and specific monitoring requirements by outfall is included in Attachment I. EPA requests that NMFS base their biological opinion (BO) on these conditions.

Permitted discharges from MTGS derive from various power plant discharge streams: once through noncontact cooling water, treated cleaning wastewater, treated flyash and bottom ash transport water, intake screen wash water and stormwater runoff. There are three attributes of the MTGS permit reissuance that have the potential to affect lifestages of shortnose sturgeon in the action area. These attributes are: 1) the thermal discharge from Outfall 001; 2) the regulated pollutants discharged from all permitted outfalls, and; 3) the operation of the CWIS at MTGS. They are described in this section.

3.1 Thermal Discharge from Outfall 001

The once through cooling system is permitted to discharge an average monthly and maximum daily flow of 68.4 MGD (47,500 gpm) of heated water from November through April of each year and 133.2 MGD (92,500 gpm) from May through October, via Outfall 001. According to the permit limits, the discharge temperature of this water cannot exceed a maximum daily temperature of 39°C (102°F) at any time during the year. The temperature rise (delta T, defined as the difference between the intake temperature and the discharge temperature) cannot exceed a maximum daily delta T of 17.7 °C (32°F) from November through April and 11.1°C (20°F) from May through October. Based on a recent test of the facility's capabilities, when operating at 100 percent power, the delta T under one pump operation (November through April limit) is approximately 14.4°C (26°F) and the delta T under two pump operation (May through October limit) is approximately 7.2°C (13°F). This is a reduction of approximately 19% from the maximum permitted delta T level currently allowed from November through April and a reduction of approximately 35% from the maximum permitted delta T level currently allowed from May through October. These updated, more accurate delta T values were used in thermal plume model runs performed by MTGS in as part of a response to an EPA information request (MTGS, May 2011).

A 1974 report prepared for the station, titled *Thermal Plume Study of the Mt. Tom Plant of Holyoke Water Power Company* (Attachment II), an August 2010 thermal plume mapping field study conducted by EPA (Attachment III), and a May 2011thermal plume model report submitted by MTGS (Attachment IV) are included as attachments to this BA to provide information which characterizes the influence of the station's thermal discharge on the Connecticut River.

Of the three reports referenced above, the MTGS May 2011 thermal plume model results represent the most comprehensive characterization of the thermal discharge under a variety of spring and summer environmental conditions. At the request of EPA, MTGS ran sixteen thermal plume model scenarios, based on parameters of maximum capacity

Station operation, typical spring river flow and expected ambient river temperatures, as well as worst case conditions of low summer river flow and elevated ambient river temperatures.

Thermal plume maps are presented in Attachment IV. An inspection of the 16 model runs shows that the thermal plume that influenced the least surface area was Scenario #4. This run used a Station flow of 70 million gallons a day (MGD) (one pump operation), an expected spring river flow of 15,000 cfs and a relatively warm ambient river water temperature of 28.3°C (83°F). A delta T of 7.2°C (13°F) resulted in a discharge temperature of 35.6 °C (96°F) before mixing with the receiving water. Under these facility operating conditions and environmental parameters, the predicted surface area of the plume with a rise above ambient river temperatures of at least 0.8 C (1.5 F) had a downstream distance of approximately 330 meters (m) a width of 25 m and a thickness of approximately 1 m below the surface (Appendix IV; Figures 4 and 17D).

The thermal plume that influenced the greatest amount of surface area was Scenario #14. This run used a Station flow of 140 MGD (two pump operation), an expected summer low river flow of 3,000 cfs and a relatively warm ambient river water temperature of 28.3°C (83°F). A delta T of 14.5°C (26°F) resulted in a discharge temperature of 42.8°C (109°F) before mixing with the receiving water. Under these facility operating conditions and environmental parameters, the predicted surface area of the plume with a rise above ambient river temperatures of at least 0.8°C (1.5°F) had a downstream distance of approximately 2001m, a width of approximately 165m and a thickness of approximately 1.6m below the surface (Appendix IV; Figures 14 and 20B). This model run was performed to simulate a “worse case” summer operating scenario. Under real operating conditions regulated by the permit, the discharge temperature cannot exceed 39°C (102°F) before mixing with the receiving water.

3.2 Regulated Pollutants Discharged from All Permitted Outfalls

The permitted discharge limits have been developed to ensure that discharges will not cause or contribute to violations of the Massachusetts Water Quality Standards (WQS) in the Connecticut River. The Massachusetts WQS include turbidity, dissolved oxygen and other standards to protect aquatic life and incorporate EPA's aquatic life criteria for toxic pollutants, which were designed to be protective of the most sensitive aquatic species nationwide.

pH

At this time, EPA anticipates that the discharges from each outfall maintain a pH of 6.5 – 8.3, except at outfall 002. Outfall 002 is an internal outfall that discharges wastewater treatment plant effluent. The pH limits at outfall 002 are 6.5 – 9.0 based on 40 C.F.R. § 423.12(b)(1)).

Total Suspended Solids

At this time, EPA anticipates the same TSS concentration limitations at each outfall location as in the existing permit. The average monthly and daily maximum limits of 30 mg/L and 100 mg/L respectively, are based on the Steam Electric Effluent Limitations Guidelines (ELGs) at 40 C.F.R. §§ 423.12(b)(3) and (4) and §§ 423.15(c) and (f) for both the wastewater treatment system effluent (outfall 002) and the bottom ash transport wastewater (outfall 008 and 009). The same limits for TSS are applied to the stormwater (outfalls 003, 004, 007, and 009a). These limits are based on best professional judgment of water quality considerations.

Oil and Grease

At this time, EPA anticipates the same O&G concentration limitations at each outfall location as in the existing permit. The average monthly and daily maximum limits of 15 mg/L are based on the Steam Electric Effluent Limitations Guidelines (ELGs) at 40 C.F.R. §§ 423.12(b)(3) and (4) and §§ 423.15(c) and (f) for both the wastewater treatment system effluent (outfall 002) and the bottom ash transport wastewater (outfall 008 and 009). The same limits for O&G are applied to the stormwater (outfalls 003, 004, 007, and 009a). These limits are based on best professional judgment of water quality considerations.

Chlorine

At this time, EPA anticipates limits for total residual chlorine (TRC) or total residual oxidants (TRO) when bromine is used, based on the existing permit in accordance with the antibacksliding requirements found in 40 CFR §122.44. These limits were originally established based on Massachusetts Water Quality Standards. A monthly average limit of 0.15 mg/l and a daily maximum limit of 0.15 mg/l of TRC/TRO would assure that the facility did not exceed the chronic and acute TRC standards (0.011 ug/l and 0.019 ug/l respectively).

Copper, Iron, Nickel, Zinc

At this time, EPA anticipates limits for these metals based on the existing permit in accordance with the antibacksliding requirements found in 40 CFR §122.44. The average monthly and daily maximum limits of 1.0 mg/L were based on the Steam Electric Effluent Limitations Guidelines (ELGs) at 40 C.F.R. §§ 423.12(b)(3) and (4) and §§ 423.15(c) and (f) for both the wastewater treatment system effluent (outfall 002) and the bottom ash transport wastewater (outfall 008 and 009). An average monthly limit of 1.0 mg/L and daily maximum limit of 2.0 mg/L for both nickel and zinc were applied to these same outfall locations based on Massachusetts Water Quality Standards.

Overall Dilution

In order to gain a general idea of the interaction of the various outfalls with the receiving water of the Connecticut River, expected dilution values have been calculated using the following formula and assumptions:

The flow from each outfall	= Q_P
The low flow (7Q10) from the Connecticut River	= 1,147.2 MGD = Q_H
Dilution Factor	= $[Q_H + Q_P]/(Q_P)$ = DF

The calculated dilution factors are presented in Table 1.

Table 1. Calculated dilution factors for each outfall at MTGS using the low flow 7Q10 Connecticut River value (1,147.2 MGD).

Outfall #	Description	Average Monthly, MGD	Maximum Daily, MGD	Dilution factor
001 (May – Oct) 001 (Nov – April)	Once-thru noncontact cooling water	133.2 68.4	133.2 68.4	10:1 18:1
002	WWTP	0.216	0.360	3,188:1
003,004, 007, 009a	Storm water	Report	Report	N/A
005	Screen wash and service tank	---	0.71 (normal) 1.074 * * when fire pumps in use	1,617:1 1,069:1
006	Reflecting pool	---	0.144	7,968:1
008/009	Bottom ash transport	0.25	0.30	3,825:1
010/011	Fly ash	1.0	1.2	957:1

3.3 The Operation of the Cooling Water Intake Structure

Cooling water is withdrawn from the Connecticut River through a 345 feet-long concrete intake pipe. The intake pipe has an 8.0 foot diameter. The river opening of the pipe is fitted with metal bars, spaced 8.5 inches apart. EPA considers this location as the initial contact point of the cooling water intake structure (CWIS) with organisms in the river. The CWIS extends approximately 30 feet into the river from shore, near the bottom, on the mainstem of the Connecticut River. The river forms a bend in this area and the CWIS is located on the west bank of the river, on the inside of the bend. The intake pipe terminates at the screenwell structure which contains two bays, each with one trash rack and a 10-feet wide traveling screen with 3/8-inch square mesh. The design velocity at each traveling screen at mean low water level is approximately 1.7 feet per second (fps).

Downstream of the traveling screen, each bay contains a circulating water pump rated at 45,000 gallons per minute (gpm) and a river water pump rated at 2,500 gpm. Since only one river pump is operated at a time, the maximum design intake flow for Mount Tom Generating Station totals 92,500 gpm (133.2 MGD).

Under the proposed once-through cooling water discharge limits for outfall 001, the facility may only discharge a maximum of 68.4 MGD (47,500 gpm) from November through April (also referred to as one pump operation). This limits the withdrawal of water from the CWIS to the same flow at the CWIS for this time period. Based on the opening of the intake in the river, the expected maximum intake velocity is approximately 2.1 fps during this time period.

From May through October, the facility may only discharge a maximum of 133.2 MGD (92,500 gpm; also referred to as two pump operation). This limits the withdrawal of water from the CWIS to the same flow at the CWIS for this time period. Based on the opening of the intake in the river, the expected maximum intake velocity increased to approximately 4.1 fps during this time period.

Because the amount of electricity generated at MTGS has an impact on the level of non-contact cooling water required, when electricity generation is less than maximum capacity, the facility will not consistently maintain the maximum flow rates proposed by EPA at this time. For example, the average yearly water flow from outfall 001 from the years 2000 through 2004 was 85.4 MGD (2000 – 2004 MTGS Discharge Monitoring Reports). If the facility had been generating electricity at maximum capacity each year, the average yearly permitted flow would have been 100.8 MGD.

The CWIS has the potential to withdraw a maximum of approximately 1.4 % of the Connecticut River annual mean flow (9,264 MGD) from May through October (two pump operation) and approximately 0.7% of the annual mean flow from November through April (one pump operation).

When comparing the CWIS impacts to low flow conditions, the CWIS has the potential to withdraw a maximum of approximately 11.6 % of the Connecticut River 7Q10 flow (1,147.2 MGD) from May through October (two pump operation) and approximately 6.0% of the 7Q10 flow from November through April (one pump operation).

In order to better gauge how the CWIS influences the Connecticut River under real Station operation and hydrological conditions, EPA assembled documented instances of river flow and Station operation over a five year period. These values are included in Table 2.

Table 2. Connecticut River Discharge flow, averaged over five years and separated into similar months, along with the percent of river water withdrawn by Station operation during the same time period.

Connecticut River Discharge	Time period Averaged over five years	Percent of river water withdrawn by CWIS
30,000 cfs (19,389 MGD)	April, May	0.4 – 0.7%
20,000 cfs (12,926 MGD)	November, December, January	0.5%
15,000 cfs (9,695 MGD)	June	1.4%
9,000 cfs (5,817 MGD)	February, March	1.2%
7,000 cfs (4,524 MGD)	October	2.9%
5,000 cfs (3,232 MGD)	July, August	4.1%
3,000 cfs (1,939MGD)	September	6.9%

Associated with the CWIS is a debris removal system that also acts as a fish return system. The screen wash system washes debris and impinged fish off the traveling screens with 70 pounds per square inch (psi) water pressure. Debris and fish are washed into a culvert and are sluiced back to the river via an approximately 300 foot long, partially uncovered, half-pipe.

4.0 ACTION AREA

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For purposes of this Section 7 consultation support document, the action area is defined as an area of Holyoke Pool portion of the Connecticut River. The downstream boundary of the action area is located approximately 2000 m downstream of MTGS outfall 001, at approximately river km 147. This is predicted to be the area furthest downstream that is measurably influenced by the thermal plume of MTGS under "worst case" environmental and Station operation conditions. The Thermal Discharge discussion in Section 3.0 of this document details the influence of the thermal plume. The furthest upstream reach of the action area is the Montague shortnose sturgeon spawning site (river km 192).

5.0 STATUS OF AFFECTED SPECIES

5.1 Atlantic Sturgeon Listing

During ongoing consultation and general communication between EPA and NMFS regarding protected species issues in the Connecticut River, NMFS announced a final decision to list five distinct population segments (DPSs) of Atlantic sturgeon under the Endangered Species Act. The Chesapeake Bay, New York Bight, Carolina, and South Atlantic populations of Atlantic sturgeon are listed as endangered, while the Gulf of Maine population is listed as threatened (January 31, 2012).

The following information was taken primarily from a letter dated December 19, 2011, from Patricia Kurkul, NMFS, to John Nagle, EPA, related to ESA Section 7 consultation for the permit reissuance of the Chicopee WPCF:

> Atlantic sturgeon have some potential to travel up the mainstem of the Connecticut River into the state of Massachusetts. Atlantic sturgeon are a long-lived, late maturing, estuarine-dependent, anadromous species, feeding primarily on benthic invertebrates (ASSRT, 2007). They have been historically reported in the Connecticut River as far upstream as Hadley, MA. However, significant evidence that Atlantic sturgeon moved past Enfield, CT into the upper Connecticut River was previously rare since this species tends to remain in the lower river in the range of the salt wedge (River Mile 6 – 16; Savoy and Shake, 1993). In 2006, an adult Atlantic sturgeon was observed in the spillway lift at the Holyoke dam, providing some indication that this species may move further upstream into the freshwater reaches of the Connecticut River. However, extensive sampling and the lack of any strong evidence of Atlantic sturgeon spawning indicates that the presence of this species in the vicinity of the discharge is unlikely [Chicopee WPCF Discharge].

The MTGS is approximately 7 miles upstream of the Holyoke Dam and approximately 12 miles upstream of the Chicopee facility discussed in the paragraph above. According to this information, based on the normal distribution of the species, it is highly unlikely that Atlantic sturgeon would be present in the vicinity of the MTGS intake or discharges or within the action area specified in this BA. Therefore, consultation under Section 7 of the ESA with NMFS is not required. Atlantic sturgeon is not considered in this biological assessment.

5.2 Shortnose Sturgeon

EPA, in coordination with NMFS, has determined that the action being considered in this biological evaluation may affect the endangered shortnose sturgeon (*Acipenser brevirostrum*). No critical habitat has been designated for shortnose sturgeon. This section will focus on the status of shortnose sturgeon within the action area, summoning information necessary to establish the environmental baseline and to assess the effects of the proposed sampling action.

5.2.1 Shortnose Sturgeon Life History

Shortnose sturgeon are benthic fish that are primarily found in the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including mollusks, crustaceans (amphipods, chironomids, isopods), and oligochaete worms (Vladykov and Greeley 1963; Dadswell 1979 *in* NMFS 1998). Shortnose sturgeon have similar lengths at maturity (45-55 cm fork length) throughout their range, but, because sturgeon in southern rivers grow faster than those in northern rivers, southern sturgeon mature at younger ages (Dadswell et al. 1984). Shortnose sturgeon are long-lived (30-40 years) and, particularly in the northern extent of their range, mature at late ages. In the north, males reach maturity at 5 to 10 years, while females mature between 7 and 13 years. Based on limited data, females spawn every three to five years while males spawn approximately every two years. The spawning period is estimated to last from a few days to several weeks. Spawning begins from late winter/early spring (southern rivers) to mid to late spring (northern rivers) when the freshwater temperatures increase to 8-9^{o}C.

Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse et al. 1987; Crowder et al. 1994; Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adulthood to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes.

Total instantaneous mortality rates (Z) are available for the Saint John River (0.12 - 0.15; ages 14-55; Dadswell 1979), Upper Connecticut River (0.12; Taubert 1980), and Pee Dee-Winyah River (0.08-0.12; Dadswell et al. 1984). Total instantaneous natural mortality (M) for shortnose sturgeon in the lower Connecticut River was estimated to be 0.13 (T. Savoy, Connecticut Department of Environmental Protection, *personal communication*). There is no recruitment information available for shortnose sturgeon because there are no commercial fisheries for the species. Estimates of annual egg production for this species are difficult to calculate because females do not spawn every year (Dadswell et al. 1984). Further, females may abort spawning attempts, possibly due to interrupted migrations or unsuitable environmental conditions (NMFS 1998). Thus, annual egg production is likely to vary greatly in this species. Fecundity estimates range from 27,000 to 208,000 eggs/female (Dadswell et al. l984).

In populations that have free access to the total length of a river (e.g., no dams within the species' range in a river: Saint John, Kennebec, Altamaha, Savannah, Delaware and Merrimack Rivers), spawning areas are located at the farthest upstream reach of the river (NMFS 1998). In the northern extent of their range, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding, and overwintering activities. In spring, as water temperatures rise above 8^{o}C, pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late March to mid/late May depending upon location and water temperature. Sturgeon spawn in upper, freshwater areas and feed and overwinter in both fresh and saline habitats. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS 1998).

Shortnose sturgeon are believed to spawn at discrete sites within a river (Kieffer and Kynard (1993). In the Merrimack River, males returned to only one reach during a four year telemetry study (Kieffer and Kynard 1993). Squiers et al. (1982) found that during the three years of the study in the Androscoggin River, adults returned to a 1-km reach below the Brunswick Dam. Kieffer and Kynard (1993) determined that adults spawned within a 2-km reach in the Connecticut River for three consecutive years. Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell et al, 1984; NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 8-12^{o}C, and bottom water velocities of 0.4 to 0.7 m/sec (Dadswell et al. 1984; NMFS 1998). For northern shortnose sturgeon, the temperature range for spawning is 6.5-8.0^{o}C (Kieffer and Kynard *in press*). Individual eggs are initially discrete when spawned but become adhesive within approximately 20 minutes of fertilization (Dadswell et al. 1984). Between water temperatures of 8 and 12^{o}C, eggs generally hatch after approximately 13 days. The larvae are photonegative, remaining on the bottom for several days. Buckley and Kynard (1981) found week-old larvae to be photonegative and form aggregations with other larvae in concealment.

At hatching, shortnose sturgeon are blackish-colored, 7-ll mm long and resemble tadpoles (Buckley and Kynard 1981). In 9-12 days, the yolk sac is absorbed and the sturgeon develop into larvae which are about 15 mm total length (TL; Buckley and Kynard 198l). Sturgeon larvae are believed to begin downstream migrations at about 20 mm TL. Laboratory studies suggest that young sturgeon move downstream in a 2-step migration: a 2 to 3-day migration by larvae followed by a residency period by young of the year (YOY) fish, then a resumption of migration by yearlings in the second summer of life (Kynard 1997). Juvenile shortnose sturgeon (3-10 years old) reside in the interface between saltwater and freshwater in most rivers (NMFS 1998).

Adult shortnose sturgeon typically leave the spawning grounds soon after spawning. Non-spawning movements include rapid, directed post-spawning movements to downstream feeding areas in spring and localized, wandering movements in summer and winter (Dadswell et al. 1984; Buckley and Kynard 1985; O'Herron et al. 1993). Kieffer and Kynard (1993) reported that post-spawning migrations were correlated with increasing spring water temperature and river discharge. YOY shortnose sturgeon are believed to move downstream after hatching (Dovel 1981) but remain within freshwater habitats. Older juveniles tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes. Juveniles move upstream in spring and feed mostly in freshwater reaches during summer.

Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface (Dadswell et al. 1984; Hall et al. 1991). Adult sturgeon occurring in freshwater or fresh water tidal reaches of rivers in summer and winter often occupy only a few short reaches of the total length (Buckley and Kynard 1985). Summer concentration areas in southern rivers are cool, deep, thermal refugia, where adult and juvenile shortnose sturgeon congregate (Flournoy et al.1992; Rogers and Weber 1994; Rogers and Weber 1995; Weber 1996). While shortnose sturgeon are occasionally collected near the mouths of rivers and often spend time in estuaries, they are not known to participate in coastal migrations and are rarely documented in their non-natal river.

The temperature preference for shortnose sturgeon is not known (Dadswell et al. 1984) but shortnose sturgeon have been found in waters with temperatures as low as 2 to 3^{o}C (Dadswell et al. 1984) and as high as 34^{o}C (Heidt and Gilbert 1978). However, temperatures above 28^{o}C are thought to adversely affect shortnose sturgeon. In the Altamaha River, temperatures of 28-30^{o}C during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges.

Shortnose sturgeon are known to occur at a wide range of depths. A minimum depth of 0.6 m is necessary for the unimpeded swimming by adults. Shortnose sturgeon are known to occur at depths of up to 30 m but are generally found in waters less than 20 m

(Dadswell et al.1984; Dadswell 1979). Shortnose sturgeon have also demonstrated tolerance to a wide range of salinities. Mcleave et al. (1977) reported adults moving freely through a wide range of salinities, crossing waters with differences of up to 10 ppt within a two hour period.

5.2.2 Status and Trends of Shortnose Sturgeon Rangewide

Shortnose sturgeon were listed as endangered on March 11, 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Although the original listing notice did not cite reasons for listing the species, a 1973 Resource Publication, issued by the US Department of the Interior, indicated that shortnose sturgeon were in peril in most of the rivers of its former range but probably not as yet extinct (USDOI l973). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. In the late nineteenth and early twentieth centuries, shortnose sturgeon commonly were taken in a commercial fishery for the closely related and commercially valuable Atlantic sturgeon. More than a century of extensive fishing for sturgeon contributed to the decline of shortnose sturgeon along the east coast. Heavy industrial development during the twentieth century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery; possibly resulting in substantially reduced abundance of shortnose sturgeon populations within portions of the species' ranges (e.g., southernmost rivers of the species range: Santilla, St. Marys and St. Johns Rivers). A shortnose sturgeon recovery plan was published in December 1998 to promote the conservation and recovery of the species (NMFS 1998).

Although shortnose sturgeon are listed as endangered range-wide, the final recovery plan recognizes l9 spawning populations occurring throughout the range of the species. These populations are in New Brunswick, Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (l); New Jersey/Delaware (l); Maryland and Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2). NMFS has not formally recognized distinct population segments (DPS) of shortnose sturgeon under the ESA. Although genetic information within and among shortnose sturgeon occurring in different river systems is largely unknown, life history studies indicate that shortnose sturgeon populations from different river systems are substantially reproductively isolated (Kynard 1998) and, therefore, should be considered discrete. The 1998 Recovery Plan indicates that while genetic information may reveal that interbreeding does not occur between rivers that drain into a common estuary, at this time, such river systems are considered a single population compromised of breeding subpopulations (NMFS 1998).

Studies conducted since the issuance of the Recovery Plan have provided evidence suggesting that years of isolation between populations of shortnose sturgeon have led to morphological and genetic variation. Walsh et al. (2001) examined morphological and genetic variation of shortnose sturgeon in three rivers (Kennebec, Androscoggin, and Hudson). The study determined that the Hudson River shortnose sturgeon population differed markedly from the other two rivers for most morphological features (total length, fork length, head and snout length, mouth width, interorbital width, dorsal scute count, left lateral scute count, and right ventral scute count). Significant differences were found between fish from Androscoggin and Kennebec Rivers for interorbital width and lateral scute counts which suggests that even though the Androscoggin and Kennebec Rivers drain into a common estuary these rivers support largely discrete populations of shortnose sturgeon. The study also found significant genetic differences among all three populations indicating substantial reproductive isolation among them and that the observed morphological differences may be partly or wholly genetic.

Grunwald et al. (2002) examined mitochondrial DNA (mtDNA) from shortnose sturgeon in eleven river populations. The analysis demonstrated that all shortnose sturgeon populations examined showed moderate to high levels of genetic diversity as measured by haplotypic diversity indices. The limited sharing of haplotypes and the high number of private haplotypes are indicative of high homing fidelity and low gene flow. The researchers determined that glaciation in the Pleistocene Era was likely the most significant factor in shaping the phylogeographic pattern of mtDNA diversity and population structure of shortnose sturgeon. The Northern glaciated region extended south to the Hudson River while the southern non-glaciated region begins with the Delaware River. There is a high prevalence of haplotypes restricted to either of these two regions and relatively few are shared; this represents a historical subdivision that is tied to an important geological phenomenon that reflects historical isolation. Analyses of haplotype frequencies at the level of individual rivers showed significant differences among all systems in which reproduction is known to occur.

Waldman et al. (2002) also conducted mtDNA analysis on shortnose sturgeon from l1 river systems and identified 29 haplotypes. Of these haplotypes, 11 were unique to northern, glaciated systems and 13 were unique to the southern, non-glaciated systems. Only 5 were common to both. This analysis suggests that shortnose sturgeon show high structuring and discreteness and that low gene flow rates indicated strong homing fidelity.

Wirgin et al. (2005) also conducted mtDNA analysis on shortnose sturgeon from 12 rivers (St. John, Kennebec, Androscoggin, Upper Connecticut, Lower Connecticut, Hudson, Delaware, Chesapeake Bay, Cooper, Peedee, Savannah, Ogeechee and Altamaha). This analysis suggested that most population segments are independent and that genetic variation among groups was high.

The best available information demonstrates differences in life history and habitat preferences between northern and southern river systems and given the species' anadromous breeding habits, the rare occurrence of migration between river systems, and the documented genetic differences between river populations, it is unlikely that populations in adjacent river systems interbreed with any regularity. This likely accounts for the failure of shortnose sturgeon to repopulate river systems from which they have been extirpated, despite the geographic closeness of persisting populations. This characteristic of shortnose sturgeon also complicates recovery and persistence of this species in the future because, if a river population is extirpated in the future, it is unlikely that this river will be recolonized.

Historically, shortnose sturgeon are believed to have inhabited nearly all major rivers and estuaries along nearly the entire east coast of North America. The range extended from the St. John River in New Brunswick, Canada to the Indian River in Florida. Today, only 19 populations remain ranging from the St. Johns River, Florida (possibly extirpated from this system) to the St. John River in New Brunswick, Canada. Shortnose sturgeon are large, long-lived fish species. The present range of shortnose sturgeon is disjoint, with northern populations separated from southern populations by a distance of about 400 km. The species is anadromous in the southern portion of its range (i.e., south of Chesapeake Bay), while northern populations are amphidromous (fish move between fresh and salt water during some part of life cycle, but not for breeding; NMFS 1998). Population sizes vary across the species' range. From available estimates, the smallest populations occur in the Cape Fear (8 adults; Moser and Ross 1995) and Merrimack Rivers (100 adults; M. Kieffer, United States Geological Survey, personal communication), while the largest populations are found in the St. John (100,000; Dadswell 1979) and Hudson Rivers (61,000; Bain et al. 1998). As indicated in Kynard (1998), adult abundance is less than the minimum estimated viable population abundance of 1,000 adults for 5 of 1l surveyed northern populations and all natural southern populations. Kynard (1998) suggests that all aspects of the species' life history indicate that shortnose sturgeon should be abundant in most rivers. As such, the expected abundance of adults in northern and north-central populations should be thousands to tens of thousands of adults. Expected abundance in southern rivers is uncertain, but large rivers should likely have thousands of adults. The only river systems likely supporting populations of these sizes are the St. John, Hudson and possibly the Delaware and the Kennebec Rivers, making the continued success of shortnose sturgeon in these rivers critical to the species as a whole. While no reliable estimate of the size of either the total species or the shortnose sturgeon population in the Northeastern United States exists, it is clearly below the size that could be supported if the threats to shortnose sturgeon were removed.

5.2.3 Threats to Shortnose Sturgeon Recovery

The Shortnose Sturgeon Recovery Plan (NMFS 1998) identifies habitat degradation or loss caused by dams, bridge construction, channel dredging, and pollutant discharges, and mortality caused by impingement on cooling water intake screens, dredging and incidental capture in other fisheries, as principal threats to the species' survival.

Several natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon. Shortnose sturgeon continue to be collected incidentally in fisheries along the east coast and are likely targeted by poachers throughout their range (Dadswell 1979; Collins et al. 1996). Bridge construction and demolition projects may interfere with normal shortnose sturgeon migratory movements and disturb sturgeon concentration areas. Unless appropriate precautions are made, internal damage and or death may result from blasting projects with powerful explosives. Hydroelectric dams may affect shortnose sturgeon by restricting habitat, altering river flows or temperatures necessary for successful spawning and or migration, and causing mortalities to fish that become entrained in turbines. Maintenance dredging of Federal navigation channels and other areas can adversely affect shortnose sturgeon populations. Sturgeon can be lethally entrained in hydraulic dredges and impeller pumps. Mechanical dredges have also been documented to lethally take shortnose sturgeon. In addition to direct effects, dredging operations may also impact shortnose sturgeon by destroying benthic feeding areas, disrupting spawning migrations, and filling spawning habitat with resuspended fine sediments. Shortnose sturgeon are susceptible to impingement on cooling water intake screens at power plants. Electric power and nuclear power generating plants can impinge larger fish on cooling water intake screens and entrain larval fish in the cooling systems. The operation of power plants can also impact water quality which can adversely affect shortnose sturgeon.

Contaminants, including toxic metals, polychlorinated aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs) can have substantial deleterious effects on aquatic life including production of acute lesions, growth retardation, and reproductive impairment (Cooper 1989; Sinderman 1994). Heavy metals and organochlorine compounds are known to accumulate in fat tissues of sturgeon, but their long term effects are not yet known (Ruelle and Henry 1994; Ruelle and Kennlyne 1993). Available data suggest that early life stages of fish are more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976). Several characteristics of shortnose sturgeon life history including long life span, extended residence in estuarine habitats, and being a benthic omnivore, predispose this species to long term, repeated exposure to environmental contaminants and bioaccumulation of toxicants (Dadswell 1979). In the Connecticut River, coal tar leachate was suspected of impairing sturgeon reproductive success. Kocan et al. (1993) conducted a laboratory study to investigate the survival of sturgeon eggs and larvae exposed to PAHs, a by-product of coal distillation. Only approximately 5% of sturgeon embryos and larvae survived after 18 days of exposure to Connecticut River coal-tar (i.e., PAH) demonstrating that contaminated sediment is toxic to shortnose sturgeon embryos and larvae under laboratory exposure conditions (NMFS 1998).

Although there is scant information available on the levels of contaminants in shortnose sturgeon tissues, some research on other related species indicates that concern about the effects of contaminants on the health of sturgeon populations is warranted. Detectible levels of chlordane, DDE (1,1-dichloro-2, 2-bis(p-chlorophenyl)ethylene), DDT (dichlorodiphenyl-trichloroethane), and dieldrin, and elevated levels of PCBs, cadmium, mercury, and selenium were found in pallid sturgeon tissue from the Missouri River (Ruelle and Henry 1994). These compounds were found in high enough levels to suggest they may be causing reproductive failure and/or increased physiological stress (Ruelle and Henry 1994). In addition to compiling data on contaminant levels, Ruelle and Henry also determined that heavy metals and organochlorine compounds (i.e., PCBs) accumulate in fat tissues. Although the long term effects of the accumulation of contaminants in fat tissues is not yet known, some speculate that lipophilic toxins could be transferred to eggs and potentially inhibit egg viability. In other fish species, reproductive impairment, reduced egg viability, and reduced survival of larval fish are associated with elevated levels of environmental contaminants including chlorinated hydrocarbons. A strong correlation that has been made between fish weight, fish fork length, and DDE concentration in pallid sturgeon livers indicates that DDE increases proportionally with fish size (NMFS 1998).

Contaminant analysis was conducted on two shortnose sturgeon from the Delaware River in the fall of 2002. Muscle, liver, and gonad tissue were analyzed for contaminants (ERC 2003). Sixteen metals, two semivolatile compounds, three organochlorine pesticides, one PCB Aroclor, as well as polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) were detected in one or more of the tissue samples. Levels of aluminum, cadmium, PCDDs, PCDFs, PCBs, DDE (an organochlorine pesticide) were detected in the *adverse effect* range. It is of particular concern that of the above chemicals, PCDDs, DDE, PCBs and cadmium, were detected as these have been identified as endocrine disrupting chemicals. Contaminant analysis conducted in 2003 of tissues from a shortnose sturgeon from the Kennebec River revealed the presence of fourteen metals, one semivolatile compound, one PCB Aroclor, Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in one or more of the tissue samples. Of these chemicals, cadmium and zinc were detected at concentrations above an adverse effect concentration reported for fish in the literature (ERC 2003). While no directed studies of chemical contamination in shortnose sturgeon have been undertaken, it is evident that the heavy industrialization of the rivers where shortnose sturgeon are found is likely adversely affecting this species.

During summer months, especially in southern areas, shortnose sturgeon must cope with the physiological stress of water temperatures that may exceed 28°C. Flournoy et al.(1992) suspected that, during these periods, shortnose sturgeon congregate in river regions which support conditions that relieve physiological stress (i.e., in cool, deep thermal refuges). In southern rivers where sturgeon movements have been tracked, sturgeon refrain from moving during warm water conditions and are often captured at release locations during these periods (Flournoy et al.1992; Rogers and Weber 1994; Weber 1996). The loss and/or manipulation of these discrete refuge habitats may limit or be limiting population survival, especially in southern river systems.

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by dissolved oxygen levels below 5 mg/L. Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28^{o}C (Flournoy et al. 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal.

5.2.4 Status of Shortnose Sturgeon in the Action Area

NMFS' goal for shortnose sturgeon is to recover the species to a level that would support reclassifying this sturgeon from endangered to threatened and eventually removing them from the federal list of threatened and endangered species. The primary methods for achieving that goal in the Connecticut River are to (a) protect shortnose sturgeon from anthropogenic activities that threaten the survival of individual members of the population and (b) re-establish unimpeded movement of shortnose sturgeon throughout their historic range in the Connecticut River.

Natural mortality is a factor that should be considered when estimating the impacts to species recovery. Taubert (1980) estimated the total instantaneous mortality rate to be 0.12 for adult shortnose sturgeon in the Holyoke Pool portion of the Connecticut River. It is likely that the fishing mortality rate is very low in this population, so the natural mortality rate is probably very close to the instantaneous mortality rate (NMFS 1998). Using catch curves and Hoenig's technique, total instantaneous natural mortality for shortnose sturgeon in the Connecticut River estuary was estimated to be 0.13 (T. Savoy *personal communication, in* NMFS 1998).

The Holyoke Dam separates shortnose sturgeon in the Connecticut River into an upriver group (above Holyoke Dam) and a lower river group that occurs below Holyoke Dam to Long Island Sound. The abundance of the upriver group has been estimated by mark-recapture techniques using Carlin tagging (Taubert 1980) and PIT tagging (Kynard unpublished data). No information exists on the historical numbers of shortnose sturgeon in the Connecticut River prior to the late 1970s. Estimates of total abundance calculated in the early1980s range from 297 to 516 in the upriver population to 800 in the lower river population. Population estimates conducted in the 1990's indicated populations in the same range. The total upriver population estimates ranged from 297 to 714 adult shortnose sturgeon, and the size of the spawning population was estimated at 47 and 98 for the years 1992 and 1993 respectively. The lower Connecticut River population estimate for sturgeon >50 cm TL was based on a Carlin and PIT tag study from 1991 to 1993. A mean value of 875 adult shortnose sturgeon was estimated by these studies. Savoy (2004) estimates that the lower river population may be as high as 1,000 individuals, based on tagging studies from 1988-2002. Other estimates of the total adult population in the Connecticut River have reached 1,200 (Kynard 1998), and based on Savoy's recent numbers, the total population may be as high as 1,400 fish.

Taubert (1980) reported that Connecticut River shortnose sturgeon exhibited relatively good growth until 8 to 10 years after which it declined rapidly. The average length of shortnose sturgeon at age 10 was 70.1 cm, but shortnose sturgeon at age 25 were only 90 cm in length. The largest shortnose sturgeon recoded by Talbert was 111 cm in length. While the majority of shortnose sturgeon captured in this study were between 8 and 18 years of age, shortnose sturgeon in excess of 25 years were not uncommon.

Shortnose sturgeon in the Connecticut River reach sexual maturity at approximately age 8. In the Connecticut River, Buckley and Kynard (1985) found that spawning lasted 2-5 days in 1980-1992, and Kynard (1997) noted that spawning lasted 7-13 days in 1989-1993. A more recent study (Kieffer and Kynard in press), notes a spawning period of 5-17 days during the same 26 day period each year (April 27-May 22). Shortnose sturgeon spawn in the Connecticut River from the last week of April to mid-May; after peak spring flows and in moderate, decreasing river discharge (Taubert 1980; Buckley and Kynard 1985; Kynard 1997). In the lower Connecticut River, most of the ripening shortnose sturgeon migrate to their spawning grounds in August-October and remain near the spawning areas (i.e., overwinter) until spring (Dadswell 1979; Buckley and Kynard 1985).

Several areas of the river have been identified as concentration areas. In the downriver segment, a concentration area is located in Agawam, MA which is thought to provide summer feeding and over wintering habitat. Other concentration areas for foraging and over wintering are located in Hartford, Connecticut, at the Head of Tide (Buckley and Kynard 1985) and in the vicinity of Portland, Connecticut (Savoy and Shake 1992). Shortnose sturgeon also make seasonal movements into the estuary, presumably to forage (Buckley and Kynard 1985; Savoy 2004). Above the dam, there are also several concentration areas. During summer, shortnose sturgeon congregate near Deerfield, MA, and many overwinter there. Successful spawning has been documented at two sites in Montague, MA and this is thought to be the primary spawning site for shortnose sturgeon in the Connecticut River.

In the Connecticut River, foraging occurs in the summer in both freshwater and saline reaches of the river (Buckley and Kynard 1985; Savoy and Shake 1992). One foraging area is located above Holyoke Dam and four others are located below Holyoke Dam. There is also an overwintering area located approximately 25 km downstream of the Montague spawning area. These upriver sites are probably preferred by pre-spawning shortnose sturgeon that will reproduce the following spring (Kieffer and Kynard, in press). Shortnose sturgeon in the lower river appear to migrate upstream to the area of the Holyoke Dam throughout the summer foraging season. It is possible that these fish seek to reach the upstream foraging and overwintering areas to await the spring spawning season. The migration of juvenile and adult shortnose sturgeon to points downstream of the Holyoke Dam appears to be a natural event coincidental with increased river discharges (Seibel 1991; Kynard 1997).

Adult shortnose sturgeon remain in freshwater all year in the Connecticut River, but some adults briefly enter low salinity river reaches in May to June and then return upriver (Buckley and Kynard 1985; Savoy 2004). The concentration areas used by adult fish in the Connecticut River are in reaches where natural or artificial features cause a decrease in river flow, possibly creating suitable substrate conditions for freshwater mussels (Kieffer and Kynard 1993), a major prey item for adult sturgeon (Dadswell et al. 1984). Both adults and juveniles have been found to use the same river reaches in the Connecticut River and have summer home ranges of about 10 km (Savoy 1991; Seibel

1991). The wintering range is usually less than 2 km, with fish congregating in deep areas, usually within or near the summer range (Seibel 1991). Foraging adults prefer curved or island reaches in the summer, not straight runs, and appear to prefer gravel and rubble substrate in the summer but sand in the winter. Fish foraging activity is almost equal during day and night but most adult sturgeon occur in slightly deeper water during the day than at night.

In 1983, Buckley and Kynard identified a shortnose sturgeon spawning site below Holyoke Dam. This area was initially determined to be a spawning area based on the relatively high numbers of telemetered sturgeon concentrating in the region during the spring spawning season. Investigation of this site, however, has provided evidence of successful spawning in very few years. In 1985, 4 eggs and 4 embryos were recovered (Buckley and Kynard 1985). In 1998, one egg was collected at Holyoke and during 1999 seven eggs were collected at Holyoke (4 of the eggs were dead and the remaining 3 were in an early stage of development). This suggests that a limited amount of spawning may occur below the Holyoke Dam, but given the numbers of eggs and larvae captured at the upstream versus the downstream spawning sites, it is clear that spawning at Montague (the upriver site) is significantly more successful.

Two areas (Rock Dam and below Cabot Station) near Montague, have more consistently been found to provide spawning habitat for shortnose sturgeon. This spawning habitat is located at river km 190-192 and is the most upstream area of use. It is located just downstream of the species' historical limit in the Connecticut River at Turners Falls (river km 198). Across the latitudinal range of the species, spawning adults typically travel to approximately river km 200 or further upstream where spawning generally occurs at the uppermost point of migration within a river (Kynard 1997; NMFS 1998). The Montague sites have been verified as spawning areas based on successful capture of sturgeon eggs and larvae in 1993, 1994, and 1995, that were 190 times the number of fertilized eggs and 10 times the number of embryos found in the Holyoke site (Vinogradov 1997). In seven years of study (1993-1999), limited successful spawning, as indicated by capture of embryos or late stage eggs, occurred only once (1995) at

Holyoke Dam (Vinogradov 1997; Kynard et al. 1999). Using this same measure, successful spawning occurred at Montague during 4 of 7 years. Both Montague and Holyoke sites have been altered by hydroelectric dam activities, but all information suggests that females spawn successfully at Montague, not at Holyoke Dam. Thus, it appears that most, if not all, recruitment to the population comes from spawning in the upriver segment.

The Montague area is in the 1.4-km reach from the Rock Dam to 200 m downstream of Cabot Station. In this area, river depths are less than 10 m and all common types of river habitat are present. Much of the river bottom in the natural river bed and in the tailrace of Cabot Station is rock and rubble. The 0.5-km river reach downstream of Cabot Station contains rubble/boulder shoals that can be exposed briefly in spring during low river discharge and low Cabot Station generation.

Kieffer and Kynard (in press), conducted a multiyear study (1993-2003) on the pre-spawning migration and spawning of Connecticut River shortnose sturgeon. Seventy-two adults were tracked from the four wintering sites, with 54 adults tracked during two or more spring periods. During this ten year period, only eighteen (25%) of the adults initiated a pre-spawning migration. The study observed 27 (26 males, 1 female) pre-spawning migrations from wintering areas. Twenty-four of the pre-spawning adults wintered at Whitmore and initiated a pre-spawning migration from there. Three males wintered and initiated migration from other winter sites (Second Island, Hatfield, and Elwell Island). While river discharge, day length and moon phase differed when migrations began, males left Whitmore each year during similar temperatures (7.0-9.2ºC). Fifty-one non-spawning adults were also tracked as they left Whitmore. Adults left Whitmore on similar dates to the spawning adults. Most non-spawning adults left Whitmore at the same time or within a week of pre-spawning migrants (i.e., by the first week in May). However, during all years, some adults remained at the winter site through early June, suggesting that they were foraging at the winter site.

Tracking also occurred at the Deerfield Confluence Area. Many of the fish radio-tagged at Deerfield migrated to Montague, with several of the males moving back and forth between Deerfield and Montague at least once. A group of non-spawners was also located at Deerfield. Some of these fish stayed at Deerfield until at least November, suggesting that the Deerfield area is used by adults in all reproductive stages during spring and summer.

A total of 450 males and 55 females were captured and measured at Montague during 1993-2003. Abundance estimates at the Montague site during spawning ranged from 14 to 360 adults. Spawning was documented to have succeeded in 1993, 1994, 1995, 1998-2000 and 2003 and spawning failed in 1996, 1997, 2001 and 2002. The mean abundance of adults for the years when spawning succeeded was significantly higher (198) than in years when spawning failed (50). Spawning succeeded more often at Cabot Station (7 years) than at Rock Dam. For the 11 years of the study, successful spawning only occurred for 7 years. In all years, spawning occurred from April 27-May 22, lasting from 5-17 days (mean 8.3 days). Even during years when spawning occurred, tracking indicated that some females did not spawn. While females spawned at either Cabot Station or Rock Dam, some males likely spawned at both locations. In 2002, spawning failed because the pre-spawning migration failed (no females and only two males were captured at Montague).

During spawning, the daily mean temperatures at Cabot Station were 6.5-14.7ºC and the mean temperatures when spawning occurred at Rock Dam were 9.1-14.5ºC. Females spawned in water depths of 1-5 m with a peak at 1.5-1.9 m. Bottom water velocity at spawning site was a mean of 70 cm/s with the greatest usage of 75-125 cm/s. The only substrate type females used was cobble/rubble (101-300 mm diameter).

Suitable spawning windows were determined to be based on day length, water temperature and water discharge. Endogenous physiological factors controlled by day length set the duration of the potential spawning window. For the Connecticut River, this period is from April 27-May 22. Within this window, temperature and discharge must overlap for spawning to occur. Kieffer and Kynard estimated that during the period of 1904 and 1991, 33 years had unsuitable discharge and 7 years likely had failed pre-spawning migrations. Thus, of these years, spawning likely failed for 40 years and was unknown for 2 years (due to unusual discharge patterns). The longest period of suitable discharge at Cabot Station was 5 consecutive years (1948-1952 and 1964-1968) and the longest period of unsuitable discharge was 4 consecutive years (1969-1972). The results of this analysis clearly indicate that shortnose sturgeon spawning in the Connecticut River does not occur every year. The cause of these failures has not yet been identified.

Pre-spawning males moved at a mean ground speed of 4 km/day and females moved 3-10 km/day. This is significantly slower than ground speeds recorded during summer and fall (16-20 km/day; Buckley and Kynard 1985). This suggests that pre-spawning adults, who have not foraged since November, may be conserving energy for spawning. The migration route for all adults leaving the winter site was the channel.

Two wintering and migration strategies appear to be used by Connecticut River pre-spawning females. Most females downstream of the Holyoke Dam that could spawn the next spring, attempt to migrate upstream to Deerfield during the summer or early fall preceding spawning (Kynard et al. in press). When displaced over the dam, most were disoriented and returned downstream before spawning, but two remained upstream, summered at Deerfield, wintered at Whitmore and migrated to spawn at Montague. The migration and behavior of these two fish likely shows the natural movement pattern of downstream segment females if upstream passage was available over Holyoke Dam. The choice by pre-spawning females to winter at Whitmore, closest to Montague, strongly suggests that this choice is adaptive and likely has energetic benefits from a shorter spring spawning migration.

Many males spawned during several conservative years, but no male spawned every year. The interval of spawning for females was 6 years or more and highly variable. It should be noted that these males and females were from the upstream population segment and that unlike the downstream population segment, these fish do not have access to the mineral and forage resources in the estuary. Kieffer and Kynard (in press) suggest that female spawning periodicity in a reunited Connecticut River population would likely show a shorter time interval between spawning of females.

Vinogradov (1997) conducted a detailed comparison study of the Holyoke and Montague spawning sites, but did not detect significant differences in habitat parameters (substrate quality, bottom velocity, water temperature). The researchers hypothesized that sturgeon are spawning site specific and that there is a strong behavioral drive to move upriver. The investigators argued that Holyoke Dam may have less of an effect on the potential population size (by limiting the number of spawners) than on the compromise to gene flow, which is extremely significant in a population where high levels of demographic stochasticity may determine the population's long term viability.

Monitoring of spawner abundance in the Connecticut River indicated that abundance varies greatly from year to year: in 1992 there were 47 spawners, while in 1993, 98 spawners were detected (Kieffer and Kynard unpublished data). Sampling in 1998 revealed that spawning at both locations was mainly unsuccessful, except for a rare female at Montague and Holyoke. In fact, all evidence indicates that, until 1999, there had been limited or no significant reproduction since 1995 (Kynard et al.1999). Further, it appears that not every mature female spawns successfully. In the Connecticut River, one of four female shortnose sturgeon removed for egg culture in 1988 could not spawn due to a tumor (Kynard personal observation), suggested to be due to exposure to coal tar leachate in the river.

In 1997, an ecological risk analysis was conducted for shortnose sturgeon in the Connecticut River by Applied Biomathematics (Root and Akcakaya 1997). The analysis concluded that the stability observed in upriver and downriver populations of shortnose sturgeon in the Connecticut River would be possible under two conditions: reproduction in both upper and lower populations and small to moderate rates of dispersal between them; or no fecundity in the lower population, very high fecundity in the upper population and a high rate of net downstream dispersal.

6.0 ENVIRONMENTAL BASELINE

Environmental baselines include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this biological evaluation includes the effects of several activities that may affect the survival and recovery of the endangered species in the action area. The activities that shape the environmental baseline in the action area of this consultation generally include: power plant operations, coal tar deposits, fisheries, research projects, and water quality.

6.1 Effects of Federal Actions that have Undergone Formal or Early Section 7 Consultation

NMFS has undertaken ESA Section 7 consultations to address the effects of federal actions on threatened and endangered species in the action area. Each of those consultations sought to develop ways of reducing the probability of adverse impacts of the action on listed species. On June 1992, NOAA Fisheries issued a Biological Opinion (BO) to the New England District Army Corps of Engineers (ACOE) for maintenance dredging of the Connecticut River Federal Navigation Project. The BO concluded that the proposed long-term maintenance dredging project was likely to jeopardize the continued existence of shortnose sturgeon in the Connecticut River due to the high number of shortnose sturgeon expected to be killed or otherwise affected by hopper dredging operations. In cooperation with the ACOE, NOAA Fisheries developed a reasonable and prudent alternative (RPA) which would avoid jeopardy to shortnose sturgeon in the Connecticut River. The RPA included a time of year restriction and a change in disposal location. The accompanying Incidental Take Statement (ITS) indicated that NOAA Fisheries believed up to 10 shortnose sturgeon were likely to be taken from dredging operations on an annual basis but due to difficulty in monitoring take, the ITS exempted the take of five observed mortalities in the dredge hopper annually. This action has been ongoing since the 1960's and continues today. Dredging occurs early every year.

On January 27, 2005, NOAA Fisheries issued a BO on the effects of the Federal Energy Regulatory Commission's (FERC) proposal to issue a new License Order for the Holyoke Hydroelectric Project on the Connecticut River in Massachusetts. The Holyoke Dam has impeded or permanently obstructed natural upstream and downstream migration of the Connecticut River population of shortnose sturgeon for 150 years. Shortnose sturgeon above the dam have access to spawning habitat but not to downstream foraging habitat. Sturgeon below Holyoke Dam have access to foraging habitat but have great difficulty accessing upstream spawning habitat. In cooperation with the FERC, NOAA Fisheries developed a Settlement Agreement which would avoid jeopardy to shortnose sturgeon in the Connecticut River.

6.2 Non-Federally Regulated Actions

Unauthorized take of shortnose sturgeon is prohibited by the ESA. However, shortnose sturgeon are taken incidentally in anadromous fisheries along the East Coast and may be targeted by poachers (NMFS 1998). The Connecticut River is an important corridor for migratory movements of various species including alewife (*Alosa pseudoharegus*), American eel (*Anguilla rostrata*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissim*a), and striped bass (*Morone saxatilis*). It has been estimated that approximately 20 shortnose sturgeon are killed each year in the commercial shad fishery operating in the Northeast and an additional number are also likely taken in recreational fisheries (T. Savoy pers. comm. in NMFS l998). Due to lack of reporting, no information on the number of shortnose sturgeon caught and released or killed in commercial or recreational fisheries on the Connecticut River is available.

6.3 Impacts of Other Potential Sources of Impacts in the Action Area

Scientific Studies

Previous research projects conducted in the Connecticut River since 1976 may have influenced shortnose sturgeon survival, reproduction and/or migration. Research projects conducted in the action area include capture, measuring, weighing, tagging (internal and external) and obtaining eggs from shortnose sturgeon. Currently three ongoing research projects are permitted by NOAA Fisheries. Boyd Kynard (*formally* USGS), Tom Savoy (Connecticut Department of Environmental Protection), and Chris Tomichek (Kleinschmidt Associates) possess ESA Section 10(a) (1) (A) Permits to conduct scientific research on shortnose sturgeon in the Connecticut River.

Impacts of Contaminants and Water Quality

Heavy usage of the Connecticut River and development along the waterfront has likely affected shortnose sturgeon throughout the action area. Construction sites often result in excessive water turbidity, which could influence sturgeon spawning and/or foraging ability. Industries along the Connecticut River include or have included in the past, hydroelectric and other energy generating facilities, an armory, firearms factory, industrial mills and various other industrial pursuits. The effect of general pollution on shortnose sturgeon in the Connecticut River is unknown.

Pulp mill, silvicultural, agricultural, and sewer discharges, as well as a combination of non-point source discharges, which contain elevated temperatures or high biological demand, can reduce dissolved oxygen levels. Shortnose sturgeon are known to be adversely affected by low oxygen levels (below 5 mg/L). Shortnose sturgeon may be less tolerant of low dissolved oxygen levels in high ambient water temperatures and show signs of stress in water temperatures higher than 28ºC (Flournoy et al. 1992). At these temperatures, concomitant low levels of dissolved oxygen may be lethal. Point source discharge (i.e., municipal wastewater, paper mill effluent, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of sturgeon populations. The compounds associated with discharges can alter the pH of receiving waters, which may lead to mortality, changes in fish behavior, deformations, and reduced egg production and survival.

The New England Interstate Water Pollution Control Commission issued a report in early 1998 on water quality threats. This report indicated that the Connecticut River had several major water quality issues. These included: toxins, such as PCBs; combined sewer overflows (CSOs) which can cause poor water quality conditions in urban areas after storm events; and non-point source pollution. All four of the states with Connecticut River waters have public health advisories regarding the consumption of fish caught in the river (MA: PCBs, CT: mercury and PCBs). The CRWC has also identified acid rain and atmospheric deposition of mercury and other contaminants as a problem throughout the watershed.

Coal tar deposits released in the Connecticut River have likely affected spawning success, egg survival and/or larval development. Coal tar contains toxic Polycyclic Aromatic Hydrocarbons (PAHs) that are known to be carcinogenic. Other pollutants in the Connecticut River, such as polychlorinated biphenyls (PCBs), could affect shortnose sturgeon reproduction as well. In the Connecticut River, coal tar leachate was suspected of impairing sturgeon reproductive success. Kocan et al. (1993) conducted a laboratory study to investigate the survival of sturgeon eggs and larvae exposed to PAHs, a by-product of coal distillation. Only approximately 5% of sturgeon embryos and larvae survived after 18 days of exposure to Connecticut River coal-tar (i.e., PAH) demonstrating that contaminated sediment is toxic to shortnose sturgeon embryos and larvae under laboratory exposure conditions (NMFS 1998). There are several known coal tar contaminated sites below the Holyoke Dam that have only recently begun to be cleaned up. It is likely that these sites as well as any others have had adverse effects on any shortnose sturgeon present in the action area over the years.

Impacts of Invasive Species

A number of invasive species are known to exist in the watershed. These species have been inadvertently and purposefully introduced to the Connecticut River watershed by humans. These include non-native fish, common reed, purple loosestrife, Eurasian milfoil, water chestnut, mute swans, Asiatic clams, and wooly adelgids. The potential for these species to affect shortnose sturgeon is currently unknown.

Impacts of Dams, Hydroelectric and Other Power Plants

The presence of dams on the Connecticut River could effect shortnose sturgeon migration. There are 16 dams upstream of the Holyoke Dam on the river's mainstem, and one breached structure downstream of Holyoke. The Enfield Dam was constructed in 1902 and is located at rkm 110, downstream from the Holyoke Dam. It is a 1.7 meter canal wing dam which may impede the movement of upstream migrating shortnose sturgeon during periods of extreme low water (Buckley 1982; Buckley and Kynard 1983). The dam was breached in 1977 and is currently passable to fish in at least four locations. Historical information documents the migration of adult shortnose sturgeon upstream past the Enfield Rapids and the dam as far back as 1912, well before the breaches occurred. Historical information also suggests that the Enfield Dam never functioned as a permanent barrier, but rather as a seasonal impediment to the upstream movement of shortnose sturgeon. The Holyoke Dam is the first barrier to migratory fish on the mainstem Connecticut River.

Changes in the natural flows and natural flow fluctuations may affect sturgeon spawning. High river flows during the normal shortnose sturgeon spawning period can cause unacceptably fast bottom water velocities and prevent females from spawning. This situation was observed in the Connecticut River in early May of 1983 and 1992 when flows were higher than normal and temperatures were lower than normal, but still adequate for spawning (Buckley and Kynard 1985, Kynard 1997). Buckley and Kynard (1985) and Kieffer and Kynard (in press) speculated that the reproductive rhythm of females may be under endogenous control and suitable river conditions must be available or endogenous factors prevent females from spawning. Thus, reproductive success depends on suitable river conditions during the spawning season.

Regulation of the Connecticut River creates discharge regimes that may affect the spawning of females and survival of early life stages. There are a series of ACOE dams on tributaries located upstream of Montague. These dams are used to control floods and as spring river discharge decrease, the ponded waters are released from the dam. This extends the cool, high discharge period beyond natural conditions. The extension of this discharge for even a week is likely sufficient to close the discharge window and cause spawning failure (Kieffer and Kynard in press).

Impingement of shortnose sturgeon on power plant cooling water intake screens may also have contributed to sturgeon mortality in the Connecticut River. This is likely to be a problem at facilities with screens with larger mesh sizes and high water velocities.

Conservation and Recovery Actions Reducing Threats to Listed Species

In 1998, NMFS issued the Final Recovery Plan for shortnose sturgeon (NMFS 1998). The long-term recovery objective for shortnose sturgeon is to recover all discrete population segments to levels of abundance at which they no longer require protection under the ESA. To achieve and preserve minimum population sizes for each population segment, the final recovery plan recommends identifying and preserving essential habitats and monitoring and minimizing mortality. Other key recovery tasks are to define essential habitat characteristics, assess mortality factors, and protect shortnose sturgeon through applicable federal and state regulations.

Summary and Synthesis of the Status of the Species and Environmental Baseline

In summary, the potential for activities described above that may have previously impacted listed species to affect shortnose sturgeon remains throughout the action area of this consultation. As described in the subsection *Status of Shortnose Sturgeon in the Connecticut River*, and the Environmental Baseline, shortnose sturgeon and their habitat in the Connecticut River have been affected by several different factors including: impaired water quality from both point and non-point sources; incidental take in scientific studies and commercial and recreational fisheries; construction and demolition of bridges; dredging activities; and, the operation of hydroelectric and other dams and electric generating facilities. While over 1,000 shortnose sturgeon likely inhabit the Connecticut River, this number is below the expected carrying capacity of this river without anthropogenic impacts on this river system. While the most recent population estimates suggest that the population is stable, and perhaps slowly increasing (Savoy 2004), this population still faces threats in this river system.

7.0 EFFECTS OF THE ACTION

This section assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). This section examines the likely effects (direct and indirect) of the proposed action on shortnose sturgeon in the action area and their habitat within the context of the species, current status, the environmental baseline and cumulative effects.

7.1 Potential Effects to Shortnose Sturgeon Due to the Action

7.1.1 Introduction

Adult and Juvenile Shortnose Sturgeon

In the Connecticut River in general, shortnose sturgeon exhibit three distinct movement patterns. These migratory movements are associated with spawning, feeding and overwintering activities (Response to EPA IR, May 2011). From 2006 through 2009, a multi-year study was conducted to determine the shortnose sturgeon routes of passage at Holyoke Dam as a relicensing requirement (Normandeau 2010). During 2006, gill net sampling was conducted in the reach of the river near MTGS, starting at the Holyoke Dam and moving progressively upstream. No shortnose sturgeon were collected in this reach of the river. A total of 57 shortnose sturgeon were collected and fitted with tracking devices during a 2007 – 2009 study. No shortnose sturgeon were detected near MTGS, nor in the vicinity of the upstream area of the Holyoke Dam (MTGS, 2011). This supports the premise that there are no shortnose sturgeon concentration areas in the vicinity of MTGS. The closest shortnose sturgeon concentration area to MTGS may be the winter concentration area identified at Elwell Island, at river km 159 (Kynard et al.1999). This is approximately eleven river kilometers upstream from MTGS. However, the movement of the upstream population segment of adult and juvenile shortnose sturgeon in the Holyoke Pool portion of the Connecticut River will likely result in their transit past the MTGS as they travel upstream or downstream. Therefore, there is the potential for this protected species to come in contact with the MTGS and its associated activities.

Early Life Stages (Eggs and Larvae) of Shortnose Sturgeon

In the Holyoke Pool Action Area, shortnose sturgeon spawning sites have been documented approximately 20 miles (32 kilometers) upstream of MTGS. There are no know shortnose sturgeon spawning areas downstream of the MTGS that are within the action area. Sturgeon eggs are demersal and adhesive, so are not expected to drift the long distance downstream to come in contact with the any potential MTGS river impacts. While shortnose sturgeon larvae are not generally thought to disperse far downstream from their spawning grounds, under certain conditions they have the potential to drift downstream to the area where the MTGS river impacts occur (Julie Crocker, NMFS May 27, 2008, e-mail to John Nagle, EPA). NMFS predicted that the larvae may be present in the months of May and June (letter from Patricia Kurkul, NMFS to David Webster, EPA, August 5, 2008). An examination of the potential impacts from these interactions follows.

There are three attributes of the MTGS permit reissuance that have the potential to affect larval, juvenile and adult lifestages of shortnose sturgeon in the action area. These attributes are: 1) the thermal discharge from Outfall 001; 2) the regulated pollutants discharged from all permitted outfalls, and; 3) the operation of the CWIS at MTGS.

7.1.2 Thermal Discharge Impacts on Shortnose Sturgeon

The MTGS once through cooling system is permitted to discharge an average monthly and maximum daily flow of 68.4 MGD (47,500 gpm) of heated water from November through April of each year and 133.2 MGD (92,500 gpm) from May through October, via Outfall 001. The facility is capable of producing a delta T under one pump operation

(November through April) of approximately 14.4°C (26°F) and a delta T under two pump operation (May through October) of approximately 7.2°C (13°F). According to the permit limits, the temperature of the discharge water cannot exceed a maximum daily temperature of 39°C (102°F) at any time during the year.

While shortnose sturgeon have been found in waters as high as 34°C (93.2°F) (Heidt and Gilbert 1978), temperatures above 28°C (82.4°F) are thought to adversely affect shortnose sturgeon. They have been documented to show signs of stress in water temperatures higher than 28°C (82.4°F) (Flournoy et al. 1992). In the Altamaha River, temperatures of 28-30°C (82.4-86°F) during summer months create unsuitable conditions and shortnose sturgeon are found in deep cool water refuges.

With a discharge temperature of 39°C (102°F) before mixing, the initial discharge from outfall 001, before mixing with the receiving water is well underway, has the potential to affect certain life stages of shortnose sturgeon. This potential is greatly reduced because the discharge point of outfall 001 is isolated from the river by a corrugated metal wall that juts out from the west bank just above the discharge point and runs parallel to the direction of the river flow. This man-made wall channels the discharge downstream along the shallow west bank of the Connecticut River. Juvenile or adult shortnose sturgeon are blocked by the metal wall and cannot access the initial discharge point from upstream. It is unlikely that juvenile or adult shortnose sturgeon would swim upstream into this shallow, narrow area and be exposed to the initial, high temperature portion of the thermal plume (see Attachment IV).

Free floating larval stages of shortnose sturgeon would be expected to be drifting in the stronger current near the middle of the river or along the east bank due to the influence of the upstream bend in the river. Any larvae that drifted toward the west bank would be blocked from drifting into the warmer, less mixed initial entrance of the discharge by the corrugated metal shield.

Based on the results of the 16 CORMIX model runs presented in Appendix IV, temperatures in the thermal plume could exceed 28^{o}C (82.4^{o}F) and be of concern to shortnose sturgeon. However, all model results verify that the thermal plumes are buoyant, do not block the entire river from bank to bank, or surface to bottom, remain in large part on the shallow, west portion of the river, and do not come in contact with the deeper, channelize portion of the Connecticut River. As discussed in Section 5.0 of this document, shortnose sturgeon are benthic fish that are primarily found in the deep channel sections of large rivers. In the unlikely event that juvenile or adult shortnose sturgeon leave their expected habitat and come in contact with the thermal plume, it is judged that they will first encounter the plume after it has undergone mixing with the receiving water. The edge of the plume retains temperatures only a few degrees above ambient conditions. The width and depth of the Connecticut River in this area will allow juvenile and adult shortnose sturgeon to avoid the thermal plume without impeding their movement upstream or downstream.

As mentioned previously, under certain conditions shortnose sturgeon larvae have the potential to drift to the area where the MTGS thermal plume is located. Any larvae that drift downstream to MTGS would be present in the months of May and June (letter from Patricia Kurkul, NMFS to David Webster, EPA, August 5, 2008). Based on a five year average (2000 through 2004) the highest river flows of 30,000 cfs (19,389 MGD) were recorded in May. Relatively high flows of 15,000 cfs (9,695 MGD) were recorded in June (Table 2., Section 3.0). Any shortnose sturgeon larvae that drift past MTGS during these time periods may drift into the MTGS thermal plume. However, as stated previously, free floating larval stages of shortnose sturgeon would be expected to be drifting in the stronger current near the middle of the river or along the east bank due to the influence of the upstream bend in the river. Some larvae may briefly encounter the edge of a well mixed thermal plume that does not extend far into the river from the west bank. The effects of this encounter are not likely to adversely affect the development of this life stage of shortnose sturgeon.

Based on the above analysis, EPA has made the determination that the MTGS thermal discharge is not likely to adversely affect the lifestages of shortnose sturgeon in the action area. The impacts, if any, will be insignificant or discountable.

7.1.3 Regulated Pollutant Discharge Impacts on Shortnose Sturgeon

Updated information presented in this section regarding shortnose sturgeon in the Connecticut River was obtained from, among other sources, "The Connecticut River IBI Electrofishing NMFS Biological Opinion, Connecticut and Merrimack River Bioassessment Studies" (NMFS BO, July 30, 2009) and the Draft Endangered Species Act Section 7 Consultation Biological Opinion (BO) for the Holyoke Hydroelectric Project (Federal Energy Regulatory Commission (FERC) Permit #2004), issued to FERC by NOAA Fisheries on January 27, 2005 (NMFS BO 2005). Information dealing with the potential effects of pollutants on shortnose sturgeon was obtained from, among other sources, a detailed ESA response letter from NMFS to EPA regarding the Montague WPCF, dated September 10, 2008 (Montague Letter).

pH

At this time, EPA anticipates that the discharges from each outfall maintain a pH of 6.5 – 8.3, except at outfall 002. Outfall 002 is an internal outfall that discharges wastewater treatment plant effluent. The pH limits at outfall 002 are 6.0 – 9.0 based on 40 C.F.R. § 423.12(b)(1)). A pH of 6.0 – 9.0 is harmless to most marine organisms (Ausperger 2004) and is within the normal range of pH for freshwater. MassDEP water quality assessment reports indicate that pH levels in the Connecticut River are well within this range (from 7.4-7.6; see 2003 Connecticut River WQA, page B21). As such, no adverse effects to shortnose sturgeon are likely to occur as a result of the discharge of water of this pH into the Connecticut River.

Total Suspended Solids

TSS can affect aquatic life directly by killing them or reducing growth rate or resistance to disease, by preventing the successful development of fish eggs and larvae, by modifying natural movements and migration, and by reducing the abundance of available food (EPA 1976). These effects are caused by TSS decreasing light penetration and by burial of the benthos. Eggs and larvae are most vulnerable to increases in solids.

At this time, EPA anticipates the same TSS concentration limitations at each outfall location as in the existing permit. The average monthly and daily maximum limits of 30 mg/L and 100 mg/L respectively, are based on the Steam Electric Effluent Limitations Guidelines (ELGs) at 40 C.F.R. Part 423 for both the wastewater treatment system effluent (outfall 002) and the bottom ash transport wastewater (outfall 008 and 009). The same limits for TSS are applied to the stormwater (outfalls 003, 004, 007, and 009a). These stormwater limits are based on best professional judgment.

Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). The studies reviewed by Burton demonstrated lethal effects to fish at concentrations of 580mg/L to 700,000mg/L depending on species. Sublethal effects have been observed at substantially lower turbidity levels. For example, prey consumption was significantly lower for striped bass larvae tested at concentrations of 200 and 500 mg/L compared to larvae exposed to 0 and 75 mg/L (Breitburg 1988 in Burton l993). Studies with striped bass adults showed that pre-spawners did not avoid concentrations of 954 to 1,920 mg/L to reach spawning sites (Summerfelt and Moiser 1976 and Combs 1979 in Burton l993). While there have been no directed studies on the effects of TSS on shortnose sturgeon, shortnose sturgeon juveniles and adults are often documented in turbid water. Dadswell (1984) reports that shortnose sturgeon are more active under lowered light conditions, such as those in turbid waters. Information dealing with the potential effects of pollutants on SNS was obtained from, among other sources, a detailed ESA response letter from NMFS to EPA regarding the Montague WPCF, dated September 10, 2008 (Montague Letter). With the exception of areas immediately downstream of spawning areas, shortnose sturgeon generally appear to overwinter and feed optimally in areas of high turbidity. As such, shortnose sturgeon are assumed to be as least as tolerant to suspended sediment as other estuarine fish such as striped bass.

As noted above, shortnose sturgeon eggs are less tolerant to sediment levels than juveniles and adults. In the Holyoke Pool Action Area, shortnose sturgeon spawning sites have been documented approximately 20 miles (32 kilometers) upstream of MTGS. There are no know shortnose sturgeon spawning areas downstream of the MTGS that are within the action area. Sturgeon eggs are demersal and adhesive, so are not expected to drift the long distance downstream to come in contact with the maximum TSS levels allowed from the outfalls at MTGS.

Shortnose sturgeon larvae are also less tolerant to sediment levels than juveniles and adults. Observations in the Delaware River indicated that larval populations may be negatively affected when suspended material settles out of the water column (Hastings 1983). Larval survival studies conducted by Auld and Schubel (1978) showed that striped bass larvae tolerated 50 mg/l and 100 mg/l suspended sediment concentrations and that survival was significantly reduced at 1000 mg/L. According to Wilber and Clarke (2001), hatching is delayed for striped bass and white perch eggs exposed for one day to sediment concentrations of 800 and 1000 mg/L, respectively (Montague Letter).

In a study on the effects of suspended sediment on white perch and striped bass eggs and larvae performed by the ACOE (Morgan et al. 1973), researchers found that sediment began to adhere to the eggs when sediment levels of over 1000 parts per million (ppm) were reached. No adverse effects to demersal eggs and larvae have been documented at levels at or below 50 mg/L (Montague Letter). This is above the highest level being proposed by EPA for this permit reauthorization. Based on this information, it is likely that the discharge of total suspended solids in the concentrations proposed will have an insignificant effect on shortnose sturgeon.

Oil and Grease

At this time, EPA anticipates the same O&G concentration limitations at each outfall location as in the existing permit. The average monthly and daily maximum limits of 15 mg/L are based on the Steam Electric Effluent Limitations Guidelines (ELGs) at 40 C.F.R. Part 423 for both the wastewater treatment system effluent (outfall 002) and the bottom ash transport wastewater (outfall 008 and 009). The same limits for O&G are applied to the stormwater (outfalls 003, 004, 007, and 009a). These stormwater limits are based on water quality considerations.

Chlorine

At this time, EPA anticipates limits for total residual chlorine (TRC) or total residual oxidants (TRO) when bromine is used, based on the existing permit in accordance with the antibacksliding requirements found in 40 CFR §122.44. These limits were originally established based on Massachusetts water quality standards. A monthly average limit of 0.15 mg/l and a daily maximum limit of 0.15 mg/l of TRC/TRO would assure that the facility did not exceed the chronic and acute TRC standards (0.011 ug/l and 0.019 ug/l respectively).

There are a number of studies that have examined the effects of TRC on fish (Post 1987; Buckley 1976; EPA 1986); however, no directed studies that have examined the effects of TRC on shortnose sturgeon. The EPA has set the Criteria Maximum Concentration (CMC or acute criteria; defined in 40 CFR 131.36 as equals the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time (up to 96 hours) without deleterious effects) at 0.019 mg/L. This is based on an analysis of exposure of 33 freshwater species in 28 genera (EPA 1986) where acute effect values ranged from 28 ug/L for *Daphia magna* to 710 ug/L for the threespine stickleback. The CMC is set well below the minimum effect values observed in any species tested. As the water quality criteria levels have been set to be protective of even the most sensitive of the 33 freshwater species tested, it is reasonable to assume that the criteria are also protective of shortnose sturgeon.

The anticipated TRC levels in the Connecticut River satisfy the EPA's ambient water quality criteria and are lower than TRC levels known to effect aquatic life. As such, the discharge of the permitted concentrations of TRC is likely to have an insignificant or discountable effect on shortnose sturgeon.

Metals (Copper, Iron, Nickel, Zinc)

At this time, EPA anticipates limits for these metals based on the existing permit in accordance with the antibacksliding requirements found in 40 CFR §122.44. The average monthly and daily maximum limits of 1.0 mg/L for copper and iron were based on the Steam Electric Effluent Limitations Guidelines (ELGs) at 40 C.F.R. Part 423 for both the wastewater treatment system effluent (outfall 002) and the bottom ash transport wastewater (outfall 008 and 009). An average monthly limit of 1.0 mg/L and daily maximum limit of 2.0 mg/L for both nickel and zinc are expected to be applied to these same outfall locations based on Massachusetts water quality standards.

Very few toxicity tests have been conducted with shortnose sturgeon. In the absence of species-specific chronic and acute toxicity data, EPA has identified the EPA aquatic life criteria and the available dilution as the best available scientific information in this case. At this time, EPA anticipates requirements designed to ensure that the discharges will not cause or contribute to conditions exceeding these criteria in the Connecticut River. See Table 3 for specific dilution information. As such, the discharge of the permitted concentrations is likely to have an insignificant effect on shortnose sturgeon.

Flow

Table 3. Calculated dilution factors for each outfall at MTGS using the low flow 7Q10 Connecticut River value (1,147.2 MGD).

Outfall #	Description	Average Monthly, MGD	Maximum Daily, MGD	Dilution factor
001	Once-thru noncontact cooling water	133.2 68.4	133.2 68.4	10:1 18:1
002	WWTP	0.216	0.360	3,188:1
003,004, 007, 009a	Storm water	Report	Report	N/A
005	Screen wash and service tank	---	0.71 (normal) 1.074 * * when fire pumps in use	1,617:1 1,069:1
006	Reflecting pool	---	0.144	7,968:1
008/009	Bottom ash transport	0.25	0.30	3,825:1
010/011	Fly ash	1.0	1.2	957:1

Based on the permitted limits proposed by EPA, designed to meet Massachusetts Water Quality Standards, the large dilution factors calculated for each outfall under low flow "worse case" conditions, and the expectation that adult and juvenile shortnose sturgeon will not leave their preferred deepwater channel habitat to swim along the shallow west bank of the river to come in contact with the diluted outfall discharge, EPA has made the determination that the discharge from the outfalls at MTGS is not likely to adversely affect shortnose sturgeon in the action area. In the unlikely event that shortnose sturgeon come in contact with the diluted discharge, any affects will be insignificant or discountable.

7.1.4 Cooling Water Intake Structure Operation Impacts on Shortnose Sturgeon

Potential Impacts to Adult and Juvenile Lifestages from Impingement

Introduction

Impingement of organisms occurs when water is drawn into a facility through its cooling water intake structures and organisms too large to pass through the intake screens, and unable to swim away, become trapped against the screens and other parts of the intake structure. The quantity of organisms impinged is a function of the intake structure's location, its depth, the volume and velocity of water at the entrance of the intake structure and through the screens, the seasonal abundance of various species of fish, and the size of various fish relative to the size of the mesh in any intake barrier system (e.g., screens).

Overall Impingement at MTGS

An impingement study was conducted by MTGS from July 2006 through July 2008. In all, 85 fish were impinged in the first year of the study and 250 fish were impinged in second year. In order to determine the potential impacts of impingement on all species in the Connecticut River under maximum permitted conditions, impingement projections were made assuming the facility continuously withdrew cooling water at the maximum allowed rate over the entire time of the study. Based on this projection, the facility would have impinged an estimated total of 572 fish in first year of the study (July 2006 through June 2007) and an estimated 1,695 fish in second year of the study (July 2007 through July 2008). This translated into an average yearly impingement estimate of 1,133 fish per year.

Impingement was recorded in all months, with highs in December and March through April. Species impinged included yellow perch, white sucker, spottail shiner, bluegill, gizzard shad, common shiner, Atlantic salmon. Species documented in the impingement sampling were predominantly, but not exclusively, resident species. A smaller percentage was made up of anadromous species.

Representatives of MTS determined overall impingement survival rate to be between 4 and 17%, depending on season. Based on the features of the debris removal system at the CWIS, EPA has taken a conservative approach and assumed that the mortality of fish impinged at MTGS is 100%.

The impingement rate at MTGS is projected to be approximately 0.030 fish per million gallons of circulating water withdrawn (0.030 fish/MG). As a way of general comparison to other generation facilities, this impingement rate is lower than the impingement projection calculated for West Springfield Generating Station (WSGS), which is 0.374/MG. WSGS is an electric generating facility on the Connecticut River below the Holyoke Dam. Fish mortality from the projected impingement at WSGS is thought to be approximately 40%. The impingement rate at Mirant Kendall Generating Station, on the Charles River, is projected to be approximately 0.025 fish /MG, with an associated 100% fish mortality expected from impingement.

Potential Shortnose Sturgeon Impingement at MTGS

While no shortnose sturgeon adult or juvenile lifestages were recorded during the MTGS impingement study from 2006 through 2008, there have been documented cases of shortnose sturgeon impingement at MTGS. A shortnose sturgeon was found dead in the screen wash water trough at the MTGS on October 20, 2005. The fish weighed 5.2 lbs. and was 28 inches long. On November 10, 2005, a second shortnose sturgeon was impinged at MTGS. This fish was alive and was immediately returned to the water. In 2006, two additional juvenile shortnose sturgeon were impinged at MTGS; one on July 5, 2006, and one on July 6, 2006. Both fish were approximately 24 inches in total length and appeared to be in an advanced state of decay. The advanced decay was judged to be an indication that the fish had likely died before being pulled into the CWIS structure. Through communication with NMFS staff at the time of the impingement events and a review of river discharge data, it was judged at the time that these were unusual events caused by atypical flow patterns in the Connecticut River (Phone call notes of C. Tomichek, Kleinschmidt, May 1, 2006; July 6, 2006).

A review of the river velocity components of shortnose sturgeon habitat as well as information on the swimming speed of this species is included to determine the vulnerability of juvenile and adult shortnose sturgeon to the velocity encountered at the CWIS. In daytime, shortnose sturgeon adults seek regions with bottom water velocities of 0.25 – 0.50 centimeters per second (cm/s) (NMFS, 1998). Shortnose sturgeon have been found at spawning depths of 1.2 to 10.4m deep and bottom velocities of 40 to 180 cm/s (NMFS, 1998) and between 36 and 125 cm/sec (USDOI, 1986). Prespawning shortnose sturgeon in the Connecticut River prefer areas of reduced velocity, generally between 30 – 79 cm/s. The suitability index of summer foraging sites for adult shortnose sturgeon drops below 0.5 as river velocity increases past approximately 100 cm/s (USDOI, 1986). The suitability index of nonmigratory juveniles greater than three inches in length drops below 0.5 as river velocity increases past approximately 112 cm/s (USDOI, 1986).

The swimming speeds of shortnose sturgeon have also been studied under laboratory conditions. Young of year maximum sustained swimming speed was calculated to be approximately 18 cm/s (Deslauriers and Kieffer, 2012). Under controlled velocity conditions of 10, 20 and 30 cm/s, juvenile shortnose sturgeon were judged to be relatively poor swimmers (Kieffer, et. al., 2009)

CWIS Features That Influence the Potential for Shortnose Sturgeon Impingement

As detailed in Section 3.0, river water is withdrawn at the CWIS through a 345 feet-long concrete intake pipe. The intake pipe has an 8.0 foot diameter. The river opening of the pipe is fitted with metal bars, spaced 8.5 inches apart. EPA considers this location as the initial contact point of the CWIS with organisms in the river. The space between these bars will likely allow juvenile and most moderately sized adult shortnose sturgeon to pass through, transit the concrete pipe and ultimately be deposited on the conventional 3/8 inch square mesh traveling screens. As listed previously, based on the opening of the intake in the river, the expected maximum intake velocity at the metal bars is expected to be approximately 64 cm/s (2.1 fps) from November through April and may increase to as much as an expected maximum intake velocity of approximately 125 cm/s (4.1 fps) from May through October.

While the spawning and prespawning habitat and suitability index velocity information generally brackets the maximum expected intake velocity of 64 cm/s from November through April, the intake velocity is well above the preferred adult velocity of 0.25 to 5.0

cm/s. From November through April, the expected maximum intake velocity of approximately 125 cm/s is well above all reported habitats, except for the upper range of velocity associated with shortnose sturgeon spawning habitat. Coupled with this is the relatively low young of year maximum sustained swimming speed of 18 cm/s (Deslauriers and Kieffer, 2012) and the relatively poor swimming performance of juveniles at velocities of 10, 20 and 30 cm/s, (Kieffer, et. al., 2009). Also the location of the intake is near the bottom. Shortnose sturgeon adults are considered benthic omnivores. All these factors support the reasonable judgment that juvenile and adult shortnose sturgeon are vulnerable to impingement from the CWIS of MTGS.

It is difficult to predict the number of juvenile or adult that may likely be impinged at MTGS due to the action of the five year permit reissuance. Mitigating factors include the tendency of shortnose sturgeon in the Holyoke Pool to have small home ranges and stay localized, unless migrating upstream to spawn (Taubert, 1980; Buckley, 1982). Also, as mentioned earlier, gill net sampling was conducted in the reach of the river near MTGS, starting at the Holyoke Dam and moving progressively upstream. No shortnose sturgeon were collected in the vicinity of MTGS during sampling in 2006. A total of 57 shortnose sturgeon were collected and fitted with tracking devices during a 2007 – 2009 study. No shortnose sturgeon were detected near MTGS, nor in the vicinity of the upstream area of the Holyoke Dam (MTGS, 2011). This supports the premise that there are no shortnose sturgeon concentration areas in the vicinity of MTGS. The closest shortnose sturgeon concentration area to MTGS may be the winter concentration area identified at Elwell Island, at river km 159 (Kynard et al.1999). This is approximately eleven river kilometers upstream from MTGS. However, the movement of the upstream population segment of adult and juvenile shortnose sturgeon in the Holyoke Pool portion of the Connecticut River will likely result in their transit past the MTGS as they travel upstream or downstream. During this brief time period, juvenile and adult shortnose sturgeon will be vulnerable to impingement at the CWIS of MTGS. It is likely that any shortnose sturgeon that is impinged will not survive.

Based on this analysis EPA has made the determination that the potential for impingement at the CWIS may affect and is likely to adversely affect juvenile and adult shortnose sturgeon in the action area. The previous impingement of two juvenile shortnose sturgeon in 2006 is the only quantifiable data available. It is possible that over the course of the next five years that the action is in effect, one to two juvenile or adult shortnose sturgeon may become impinged at MTGS. Impingement, in this case, will result in the direct effect of mortality.

Potential Impacts to the Larval Lifestage from Entrainment

Introduction

Entrainment by CWISs can kill large numbers of aquatic organisms. These adverse environmental impacts associated with CWISs can also contribute to reductions of local species of commercial and/or recreational importance, locally important forage species, and local threatened or endangered species [See 66 FR p.65264]. Any of these losses could, in turn, contribute to a decrease in the diversity of, or the alteration of, the community of organisms inhabiting the ecosystem.

Entrainment of organisms occurs when water is withdrawn by a facility into the CWISs from an adjacent water body. Eggs and larvae are typically small enough to pass through the mesh of the CWIS's intake screens and become entrained within the cooling water drawn through the facility. As a result, the eggs and larvae are exposed to shear forces from mechanical pumps, physical stress or injury, elevated temperatures from waste heat removal, and, in some cases, high concentrations of chlorine or other biocides. These organisms can be killed or otherwise harmed as a result of entrainment. The extent of entrainment of fish and invertebrates in cooling water intake structures is determined by several factors, including the nature of the water body in which the cooling water intake structure is located, the particular location in the water body in which the intake structure is placed, the biological community present in the water body, the volume and velocity of the waterbody and the intake flow, the nature of any intake screening system or other entrainment reduction equipment used by the facility, and season. The number of organisms that become entrained is primarily dependent upon the flow of cooling water through the plant and the concentration of organisms in the source water body that are small enough to pass through the screens of the plant's intake structure(s). [See 66 FR p. 65273].

General Entrainment Information for MTGS

A two year entrainment study was conducted from October 2008 through September 2010 for MTGS (Kleinschmidt, 2010). The great majority of ichthyoplankton collected at the intake of the cooling water system was made up of larvae. Only about 38,000 eggs were estimated to be entrained out an estimated 13 million organisms. The small number of eggs were entrained in June and July only. Although the sampling was conducted every month, larvae were only seen at the intake from April through July in Year 1 and April through August in Year 2 of the study. The Year 1 annual estimate was dominated by shiners (28%), followed by tessellated darters (20.7%), sea lamprey (16.9%, herring species (12.6%), white sucker (7.4%), and common carp. The total estimate of larvae entrained in Year 1 was approximately 2.5 million (Kleinschmidt, 2010). The Year 2 annual entrainment estimate was dominated by common carp (46.7%), followed by herring species (15.9%), shiners (12.7%), gizzard shad (7.5%) and tessellated darter (5.2%) (Kleinschmidt, 2010).

Shortnose Sturgeon Spawning and Larval Production

Smith (1985) estimated that shortnose sturgeon produce between 40,000 and 200,000 eggs per fish. Dadswell et al. (1984) reported 27,000 to 208,000 eggs for shortnose sturgeon from the St. John River, and studies by Heidt and Gilbert (1978) report shortnose sturgeon from the Altamaha River in Georgia producing between 79,000 and 90,000 eggs. However, egg production and survival rates may be significantly lower in the Connecticut River, particularly for females restricted to the lower river, due to exposure to coal tar leachate and polycyclic aromatic hydrocarbons (PAHs). For example, one of four female shortnose sturgeon removed for egg culture in 1988 could not spawn due to a tumor (Kynard personal observation), suggested to be due to exposure to coal tar leachate in the river. Kocan et al. (1993) conducted a laboratory study to investigate the survival of sturgeon eggs and larvae exposed to PAHs, a by-product of coal distillation. Only approximately 5% of sturgeon embryos and larvae survived after

18 days of exposure to Connecticut River coal-tar (i.e., PAH) demonstrating that contaminated sediment is toxic to shortnose sturgeon embryos and larvae under laboratory exposure conditions (NMFS 1998). There are several known coal tar contaminated sites below the Holyoke Dam that have only recently begun to be cleaned up. It is likely that these sites as well as any others have had adverse effects on shortnose sturgeon in the Connecticut River over the years.

Based on laboratory observation of a few shortnose sturgeon larvae, larvae probably drift downstream for the first one to two days of life, aggregate in concealment on the bottom for the next 3 to 10 days, and then begin feeding and movement (Buckley and Kynard, 1981). Larval shortnose sturgeon are apparently benthic and presumably occupy deep channel areas where water velocity is strong. (USDOI, 1986)

As mentioned previously in the Status of Affected Species Section of this document, in the Connecticut River, Buckley and Kynard (1985) found that spawning lasted 2-5 days in 1980-1992, and Kynard (1997) noted that spawning lasted 7-13 days in 1989-1993. A more recent study (Kieffer and Kynard in press), notes a spawning period of 5-17 days during the same 26 day period each year (April 27-May 22). Shortnose sturgeon spawn in the Connecticut River from the last week of April to mid-May; after peak spring flows and in moderate, decreasing river discharge (Taubert 1980; Buckley and Kynard 1985; Kynard 1997).

There are no know shortnose sturgeon spawning areas downstream of the MTGS that are within the action area. Many years of study by Dr. Boyd Kynard from the USGS Conte Anadromous Fish Laboratory demonstrate that shortnose sturgeon spawn about 20 river miles (32 kilometers) upstream of MTGS in Montague City, Massachusetts and are not usually thought to disperse far downstream from their local spawning grounds (Response to EPA Information Request, May 2011). However, under certain warmer river conditions, NMFS has judged that larvae have the potential to drift downstream to the area where the river is influenced by the MTGS CWIS (Julie Crocker, NMFS May 27, 2008, e-mail to John Nagle, EPA). NMFS predicted that the larvae may be present in the vicinity of the CWIS during the months of May and June (letter from Patricia Kurkul, NMFS to David Webster, EPA, August 5, 2008).

As listed in Section 3.0, Table 2 of this document, over a five year period from the year 2000 through 2004, MTGS withdrew an average of approximately 0.4 to 0.7 % of the actual river flow moving past the Station in the month of May and an average of approximately 1.4% of the actual river moving past the Station in June. May and June are the two months identified by NMFS having the potential for larval shortnose sturgeon entrainment at MTGS. The amount of water used in the once through cooling system of a facility is directly related to the level of entrainment effects. Because the months of May and June generally are expected to coincide with relatively high spring flows and increased current velocities in the Connecticut River, the overall influence of the 133.2 MGD CWIS withdrawal would be expected to be diminished when compared with other months that are historically characterized by lower river flows.

It is difficult to reasonably estimate how may shortnose sturgeon larvae would be entrained at MTGS over the five year permit reissuance action period because no shortnose sturgeon larvae have been documented in the vicinity of the CWIS. Based on the analysis included in this report, the number of shortnose sturgeon larvae that are judged to be susceptible to entrainment will likely be low. The reasons supporting this judgment include: 1) the small number of mature female shortnose sturgeon expected to spawn in any given year will contribute a relatively small number of eggs and larvae to the Connecticut River water column; 2) the distance from the upstream spawning areas to the MTGS CWIS; 3) the tendency of free floating larvae to remain near the middle of the river or favor the east bank of the river in the vicinity of the Station due to its location on the inside of a bend (west bank) of the mainstem of the Connecticut River; and 4). Entrainment sampling has documented no shortnose sturgeon larvae. Continuous entrainment sampling of all water withdrawn (or a large percentage) would be needed to document with any certainty the expected small number of shortnose sturgeon larvae entrained.

Should shortnose sturgeon ichthyoplankton be entrained by the MTGS CWIS, the direct effects of the proposed action may include the death, or permanent removal of larvae from the Connecticut River shortnose sturgeon population. The potential lethal entrainment of larvae is unlikely to have any significant impact on the reproduction, numbers, or distribution of shortnose sturgeon in the Connecticut River.

Based on this analysis EPA has made the determination that the potential for entrainment at the CWIS may affect and is likely to adversely affect larval shortnose sturgeon in the action area. While it is not possible to quantify the number of larval shortnose sturgeon subject to entrainment at this time, any entrainment of these organisms will result in the direct effect of larval mortality.

8.0 CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR 402.02 as the effects of future state, local or private activities that are reasonably certain to occur within the action area of the Federal action subject to consultation. The following section discusses potential cumulative effects that are reasonably certain to occur to shortnose sturgeon within the action area of this consultation.

Several features of the shortnose sturgeon's natural history, including delayed maturation, non-annual spawning (Dadswell et al. 1984) and long life-span, affect the rate at which recovery can proceed. The cumulative activities in the Connecticut River that will likely continue to impact shortnose sturgeon recovery are recreational and commercial fisheries, coal tar contaminants and other pollutants, additional Connecticut River dams, upstream hydropower development, development and construction activities resulting in excessive water turbidity and habitat degradation.

Shortnose sturgeon are currently and will continue to be impacted by anthropogenic activities in the Connecticut River. Shortnose sturgeon are protected from directed fisheries, but they are captured as bycatch from recreational fisheries. In the Connecticut River, Savoy and Shake (1992) estimated 2-25 adults were taken annually by the

American shad fishery and some fish are also caught by sport fishers angling for catfish. Poaching in the Connecticut River may also contribute to shortnose sturgeon mortality.

Shortnose sturgeon continue to be negatively impacted by the presence of coal tar deposits in the Connecticut River. Kocan et al. (1993) conducted a laboratory study to investigate the survival of sturgeon eggs and larvae exposed to PAHs, a by-product of coal distillation. Only approximately 5% of sturgeon embryos and larvae survived after 18 days of exposure to Connecticut River coal-tar (i.e., PAH) demonstrating that contaminated sediment is toxic to shortnose sturgeon embryos and larvae under laboratory exposure conditions (NMFS 1998). In addition, although no longer permitted, PCB's remain present in the Connecticut River sediments and likely has negative impacts to shortnose sturgeon. .

The presence of dams alters the natural flow fluctuations of a river. Changes in the natural flows and natural flow fluctuations are a result of dam operations. However shortnose sturgeon often spawn near hydroelectric tailraces, as they do near Cabot Station, which may indicate that the species benefits from the conditions created by hydroelectric development.

Excessive turbidity due to development and construction sites may also affect shortnose sturgeon. Shortnose sturgeon require clean rock or cobble substrate to deposit their eggs and unfavorable substances would make it impossible for eggs to adhere to critical interstitial areas. Additionally, excessive turbidity impairs shortnose sturgeon forging by making it difficult to locate prey.

9.0 INTEGRATION AND SYNTHESIS OF EFFECTS

Shortnose sturgeon are endangered throughout their entire range. This species exists as nineteen separate populations that show no evidence of interbreeding. The shortnose sturgeon residing in the Connecticut River form one of these nineteen populations.

EPA has estimated that the proposed action, will result in no significant effect on the Connecticut River shortnose sturgeon population. No other effects to shortnose sturgeon in the Connecticut River or their habitat are likely to occur as a result of this action.

There is projected to be a reduction of two juvenile /adult shortnose sturgeon and some number of larvae in the Holyoke Pool Action Area of the Connecticut River. Since there will be no reduction in the range-wide distribution of shortnose sturgeon, this action is not likely to impede the ability of the species to recover. As such, there is not likely to be an appreciable reduction in the likelihood of survival and recovery in the wild of the Connecticut River population or the species as a whole.

10.0 CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the action, and the cumulative effects, this document is submitted in support of formal consultation with NMFS regarding EPA's reissuance of Mount Tom Generating Station's NPDES permit. Because no critical habitat is designated in the action area, none will be affected by the proposed action.

Based on the above analysis, EPA has made the following determinations:

1) that the MTGS thermal discharge is not likely to adversely affect the lifestages of shortnose sturgeon in the action area. The impacts, if any, will be insignificant or discountable.

2) that the discharge from the outfalls at MTGS is not likely to adversely affect shortnose sturgeon in the action area. In the unlikely event that shortnose sturgeon come in contact with the diluted discharge, any affects will be insignificant or discountable.

3) that the potential for impingement at the CWIS may affect and is likely to adversely affect juvenile and adult shortnose sturgeon in the action area. The previous

impingement of two juvenile shortnose sturgeon in 2005 and two in 2006 are the only quantifiable data available. It is possible that over the course of the next five years that the action is in effect, two to four juvenile or adult shortnose sturgeon may become impinged at MTGS. Impingement, in this case, will result in the direct effect of mortality.

4) that the potential for entrainment at the CWIS may affect and is likely to adversely affect larval shortnose sturgeon in the action area. While it is not possible to quantify the number of larval shortnose sturgeon subject to entrainment at this time, any entrainment of these organisms will result in mortality.

EPA requests the initiation of formal consultation with NMFS, based on determinations 3) and 4) listed above.

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